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Cover image: *Zygaena speciosa speciosa* (Figs 16, 17, 19, 20 in Hofmann & Naderi: Contribution to the knowledge of the genus *Zygaena* Fabricius, 1775)

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The authorship of the taxa in the paper of Lienig & Zeller, 1846

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Abstract. The authorships of the taxa described in the paper of Lienig & Zeller, 1846, are discussed. The authorship of all species newly described in this paper should be assigned to both. A list of the taxa newly described in that paper and their current taxonomic status is provided.

Zusammenfassung. Die Autorenschaft für die in der Arbeit von Lienig & Zeller, 1846, beschriebenen Taxa wird diskutiert. Für alle in dieser Arbeit neu beschriebenen Arten sollten beide Namen als Autoren angesehen werden. Eine Liste der neubeschriebenen Taxa mit ihrem gegenwärtigen taxonomischen Status wird vorgelegt.

Introduction

In a paper on the Latvian regions of Livland and Curland (Vidzeme and Kurzeme) by Lienig and Zeller (1846) a number of species from several Lepidoptera families were newly described; however, there exist conflicting views with regard to their correct authorships. The reasons for such uncertainty lie in the ambiguous way in which the authorship of this paper is expressed: "...Bearbeitet von Friederike Lienig, geb. Berg, mit Anmerkungen von P. C. Zeller. [worked by Friederike Lienig ..., with annotations by P. C. Zeller]" and in the fact that the names of the described taxa were credited to a variety of authors: "Lienig nov. sp.;" "Zell. nov. sp.;" "nov. spec.;" "Tischer in litt.;" "Heyden nov. sp.;" "Tr[eitschke]. in litt." As a result, the new taxa were subsequently attributed variously to "Lienig", "Zeller" or "Lienig & Zeller".

Examining the text it is hardly possible to be certain in each case which part of an original description was written by Lienig and which by Zeller. Most, if not all, descriptions contain elements contributed by both authors (e.g. biological information and descriptions of the larva are usually by Lienig), and the use of the personal pronoun *I* refers in some instances to Lienig in others to Zeller. It seems therefore justified uniformly to attribute the authorship of all the taxa described as new in that paper jointly to "Lienig & Zeller".

List of the taxa newly described by Lienig and Zeller 1846, with their original attribution and their current taxonomic status

acuminatana Zell. nov. sp. (*Grapholitha*[sic!])(p. 256)
Current status: *Dichrorampha acuminatana* (Lienig & Zeller, 1846) – Tortricidae.
arctata Lienig nov. sp. (*Cidaria*) (p. 199)
Current status: *Martania taeniata* (Stephens, 1831)
Syn.: *Cidaria arctata* Lienig & Zeller, 1846 – Geometridae.
bisontella Lienig nov. sp. (*Ochsenheimeria*) (p. 274)
Current status: *Ochsenheimeria urella* Fischer v. Röslerstamm, 1842
Syn.: *Ochsenheimeria bisontella* Lienig & Zeller, 1846 – Ochsenheimeriidae.
ciniflonella Lienig nov. sp. (*Depressaria*) (p. 280)
Current status: *Exaeretia ciniflonella* (Lienig & Zeller, 1846) – Depressariidae.
comariana Lienig nov. sp. (*Teras*) (p. 263)
Current status: *Acleris comariana* (Lienig & Zeller, 1846) – Tortricidae
conterminata nov. spec. (*Larentia*) (p. 197)
Current status: *Eupithecia conterminata* (Lienig & Zeller, 1846) – Geometridae
costiguttella Lienig nov. sp. (*Gelechia*) (p. 290)
Current status: *Brachmia dimidiella* (Denis & Schiffermüller, 1775)
Syn: *Gelechia costiguttella* Lienig & Zeller, 1846
cuphana Tischer in litt. (*Grapholitha*[sic!]) (p. 245)
Current status: *Rhopobota stagnana* (Denis & Schiffermüller, 1775)
Syn.: *Grapholita cuphana* Lienig & Zeller, 1846. A junior primary homonym of *Grapholita cuphana* Duponchel, 1843 – Tortricidae, Olethreutinae.
Remarks. According to J. Baixeras (pers. comm.) this homonymy has remained hitherto unnoticed.
deauratella Lienig nov. sp. (*Coleophora*) (p. 295)
Current status: *Coleophora deauratella* Lienig & Zeller, 1846 – Coleophoridae.
diaphanella Lg. nov. sp. (*Gelechia*) (p. 285)
Current status: *Helcystogramma rufescens* (Haworth, 1828)
Syn.: *Gelechia diaphanella* Lienig & Zeller, 1846. – Gelechiidae.
flavaginella Lienig (*Coleophora*) (p. 295)
Current status: *Coleophora sternipennella* (Zetterstedt, 1839)
Syn: *Coleophora flavigenella* Lienig & Zeller, 1846 – Coleophoridae.
fuliginosella Lienig nov. sp. (*Tinea*) (p. 273)
Current status: *Elatobia fuliginosella* (Lienig & Zeller, 1846) – Tineidae.
gallicolana Heyden nov. sp. (*Grapholitha*) (p. 255)
Current status: *Pammene gallicolana* (Lienig & Zeller, 1846) – Tortricidae.
gimmerthaliana Lienig nov. sp. (*Grapholitha*[sic!]) (p. 247)
Current status: *Epinotia gimmerthaliana* (Lienig & Zeller, 1846) – Tortricidae.
Remarks: See *gimmerthaliania.*
gimmerthaliania Lienig nov. sp. (*Grapholitha*[sic!]) (p. 247)
Current status: *Epinotia gimmerthaliana* (Lienig & Zeller, 1846) – Tortricidae.

Remarks: The name *gimmerthaliania* is an incorrect (of a multiple) original spelling. Although it is used in the main heading of this species, the spelling *gimmerthaliana* commences the Latin diagnosis and was subsequently accepted as the correct spelling.

grandaevana Lienig nov. sp. (*Pedisca*) (p. 238)
Current status: *Epiblema grandaevana* (Lienig & Zeller, 1846) – Tortricidae.

hepatariella Lienig nov. sp. (*Depressaria*) (p. 282)
Current status: *Levipalpus hepatariella* (Lienig & Zeller, 1846) – Depressariidae.

hübneriana [sic!] Lienig nov. sp. (*Paedisca*) (p. 237)
Current status: *Pelochrista huebneriana* (Lienig & Zeller, 1846) – Tortricidae.

immundata nov. spec. (*Larentia*) (p. 194)
Current status: *Eupithecia immundata* (Lienig & Zeller, 1846) – Geometridae.

improbata Tr. in litt. (*Larentia*) (p. 196)
Current status: *Gymnoscelis rufifasciata* (Haworth, 1809)
Syn: *Larentia improbata* Lienig & Zeller, 1846 – Geometridae.

incana Zell. nov. sp. (*Grapholitha*[sic!]) (p. 239)
Current status: *Eucosma wimmerana* (Treitschke, 1835)
Syn: *Grapholitha*[sic!] *incana* Lienig & Zeller, 1846 – Tortricidae.

inquinatalis Lienig nov. sp. (*Scopula*) (p. 205)
Current status: *Udea inquinatalis* (Lienig & Zeller, 1846) – Crambidae.

internella Lienig nov. sp. (*Gelechia*) (p. 291)
Current status: *Thiotricha subocellea* (Stephens, 1834)
Syn: *Gelechia internella* Lienig & Zeller, 1846 – Gelechiidae.

lamana Zell. nov. sp. (*Phoxopteris*) (p. 257)
Current status: *Bactra furfurana* (Haworth, 1811)
Syn: *Phoxopteris lamana* Lienig & Zeller, 1846 – Tortricidae.

leguminana Lienig nov. sp. (*Grapholitha*[sic!]) (p. 253)
Current status: *Cydia leguminana* (Lienig & Zeller, 1846) – Tortricidae.

lienigiana v. Tischer in litt. (*Penthina*) (p. 213)
Current status: *Argyroploce lediana* Linnaeus,1758 – Tortricidae.
Syn: *Penthina lienigiana* Lienig & Zeller, 1846

lienigiella Zell. n. sp. (*Cosmopteryx*) (p. 298)
Current status: *Cosmopterix lienigiella* (Lienig & Zeller, 1846) – Cosmopterigidae.

lucivagana Lienig nov. sp. (*Sericoris*) (p. 229)
Current status: *Celypha rurestrana* (Duponchel, 1843)
Syn: *Sericoris lucivagana* Lienig & Zeller, 1846 – Tortricidae.

nitidulana Lienig nov. sp. (*Phoxopteris*) (p. 259)
Current status: *Gypsonoma nitidulana* (Lienig & Zeller, 1846) – Tortricidae.

obumbratana Lienig nov. sp. (*Grapholitha*[sic!]) (p. 240)
Current status: *Eucosma obumbratana* (Lienig & Zeller, 1846) – Tortricidae.

ochsenheimeriana Lienig nov. sp. (*Grapholitha*[sic!]) (p. 249)
Current status: *Pammene ochsenheimeriana* (Lienig & Zeller, 1846) – Tortricidae.

padana Lienig nov. sp. (*Grapholitha*[sic!]) (p. 243)
Current status: *Epinotia signatana* (Douglas, 1845) – Tortricidae.
Syn: *Grapholitha*[sic!] *padana* (Lienig & Zeller, 1846)

pallifrontana Zell. In litt. (*Grapholitha*[sic!]) (p. 251)
Current status: *Grapholita pallifrontana* Zeller, 1845
Syn: *Grapholitha*[sic!] *pallifrontana* Lienig & Zeller, 1846 – Tortricidae.
Remarks: Zeller (1845) named on p. 14 under *Grapholitha*[sic!] "1630 *Pallifrontana* Zeller: Kreisewitz, im Sommer einzeln" and figured (fig. 15) this species as *Graph. pallifrontana* in: 5. Bericht des schlesischen Tauschvereins für Schmetterlinge 1844. This figure is the valid description of the taxon.

palustrana Lienig nov. sp. (*Sericoris*) (p. 230)
Current status: *Phiaris palustrana* (Lienig & Zeller, 1846) – Tortricidae.

pascualis Lienig nov. sp. (*Botys*) (p. 206)
Current status: *Udea lutealis* (Hübner, 1809)
Syn: *Botys pascualis* Lienig & Zeller, 1846 – Crambidae.

pinicolana Zell. nov. sp. (*Grapholitha*[sic!]) (p. 242)
Current status: *Zeiraphera griseana* (Hübner, 1799)
Syn: *Grapholitha*[sic!] *pinicolana* Lienig & Zeller, 1846 – Tortricidae.

pinivorana Zell. nov. sp. (*Coccyx*) (p. 225)
Current status: *Rhyacionia pinivorana* (Lienig & Zeller, 1846) – Tortricidae.

plumbatana Zell. nov. spec. (*Grapholitha*[sic!]) (p. 249)
Current status: *Pammene splendidulana* (Guenée, 1845)
Syn: *Grapholitha*[sic!] *plumbatana* Lienig & Zeller, 1846 – Tortricidae.

postremana Lienig nov. sp. (*Sericoris*) (p. 231)
Current status: *Pristerognatha penthinana* (Guenée, 1845)
Syn: *Sericoris postremana* Lienig & Zeller, 1846 – Tortricidae.

prolongata Lienig nov. sp. (*Larentia*) (p. 198)
Current status: *Eupithecia extensaria* (Freyer, 1844)
Syn: *Larentia prolongata* Lienig & Zeller, 1846 – Geometridae.

pruinosella Lienig nov. sp. (*Gelechia*) (p. 288)
Current status: *Athrips pruinosella* (Lienig & Zeller, 1846) – Gelechiidae.

pulchella Lienig nov. sp. (*Argyresthia*) (p. 293)
Current status: *Argyresthia pulchella* Lienig & Zeller, 1846 – Argyresthiidae.

redimitella Z. in litt. (*Tin. Lampronia*) (p. 271)
Current status: *Lampronia redimitella* (Lienig & Zeller, 1846) – Prodoxidae.

ruptana Lienig (*Teras*) (p. 261)
Current status: *Acleris sparsana* (Denis & Schiffermüller, 1775)
Syn: *Teras sparsana* var. *ruptana* Lienig & Zeller, 1846 – Tortricidae.

serraria Lienig nov. sp. (*Cidaria*) (p. 200)
Current status: *Heterothera serraria* (Lienig & Zeller, 1846) – Geometridae.

splendidella Lienig nov. sp. (*Coleophora*) (p. 296)
Current status: *Metriotes lutarea* (Haworth, 1828)
Syn: *Coleophora splendidella* Lienig & Zeller, 1846 – Coleophoridae.

strigulatella Lienig in litt. (*Lithocolletis*) (p. 300)
Current status: *Phyllonorycter strigulatella* (Lienig & Zeller, 1846) – Gracillariidae.

suspectana Lienig nov. sp. (*Grapholitha*) (p. 255)
Current status: *Pammene suspectana* (Lienig & Zeller, 1846) – Tortricidae.

temerella Lienig nov. sp. (*Gelechia*) (p. 284)
Current status: *Anacampsis temerella* (Lienig & Zeller, 1846) – Gelechiidae.
torquatella Lienig nov. sp. (*Oecophora*) (p. 279)
Current status: *Atemelia torquatella* (Lienig & Zeller, 1846) – Praydidae.
vacciniana Tischer in litt. (*Grapholitha*[sic!]) (p. 248)
Current status: *Rhopobota myrtillana* (Humphreys & Westwood, 1845)
Syn: *Grapholitha*[sic!] *vacciniana* Lienig & Zeller, 1846 – Tortricidae.
vacciniella Lienig nov. sp. (*Epischnia*)
Current status: *Ortholepis vacciniella* (Lienig & Zeller, 1846) – Pyralidae.
vinctaria Lienig nov. spec. (*Idaea*) (p. 203)
Current status: *Macaria loricaria* (Eversmann, 1837)
Syn: *Idaea vinctaria* Lienig & Zeller, 1846 – Geometridae.

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The biology of *Gynnidomorpha permixtana* (Lepidoptera, Tortricidae) on *Sagittaria trifolia* L. (Alismataceae) in paddy fields in Iran

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Abstract. While testing the efficacy of herbicides on paddy weeds at the Rice Research Institute of Iran (RRII) in 2008, we encountered the failure of arrowhead (*Sagittaria sagittifolia* L., Alismataceae) seeds to germinate. Detailed investigation revealed physical damage of seeds caused by the larvae of *Gynnidomorpha permixtana* (Denis & Schiffermüller, 1775) (Tortricidae, Tortricinae, Cochylina). Further studies showed that larvae feed on the seeds and flowers of the host plant and destroy the achenes. Under laboratory conditions *G. permixtana* required 23–30 days to complete its life cycle. Arrowhead is a new host record for this moth species; furthermore, this is the first detailed record of a tortricid feeding on this plant.

Introduction

Arrowhead (*Sagittaria sagittifolia* L.; Alismataceae) is a perennial weed that is present throughout the rice growing areas of eastern Asia (Naylor 1996). It is a major weed pest of paddy rice in Iran (Mohammadsharifi 2000). Arrowhead is difficult to control due to herbicide tolerance and season-long emergence (Kwon 1993). In Korea and Japan arrowhead is ranked as the most important weed in paddy fields (Itoh and Miyahara 1988; Kwon 1993; Chung et al. 1998).

Until now eighty-two species of Cochylini from twelve genera have been recorded from Iran and these are the following: *Aethes* Billberg, 1820; *Agapeta* Hübner, 1822; *Ceratoxanthis* Razowski, 1960; *Cochylidia* Obraztsov, 1956; *Cochylimorpha* Razowski, 1960; *Cochylis* Treitschke, 1829; *Diceratura* Djakonov, 1929; *Eugnosta* Hübner, 1825; *Fulvoclysia* Obraztsov, 1943; *Gynnidomorpha* Turner, 1916; *Phalonidia* Le Marchand, 1933 and *Phtheochroa* Stephens, 1829 (Alipanah 2009).

The genus *Gynnidomorpha* Turner, 1916, assigned to the subtribe Cochylina (Tortricidae: Tortricinae), includes 17 species that are recorded from the Holarctic, Oriental, and Australian regions, with greatest species richness documented from the Palaearctic region (Sun and Li 2013). *Gynnidomorpha permixtana* (Fig. 1) is a trans-Palaearctic species, occurring from the British Isles to the Ural Mts., Afghanistan, Mongolia, China (Razowski 2002), Korea (Byun and Li 2006) and Iran (Alipanah 2009). Host plants previously reported for this moth include *Alisma* sp. (Alismataceae), *Gentiana* sp. (Gentianaceae), *Euphrasia* sp. and *Pedicularis* sp. (Scrophulariaceae) from Japan; *Alisma orientale* (Sam.) Juzepcz, *Euphrasia pectinata* M. Tenore., *Pedicularis* L., and *Gentiana lutea* L. from

Figures 1–2. *Gynnidomorpha permixtana* morphological characteristics: **1.** Adult; **2.** Genitalia slide (Photo: L. Aarvik).

China; and *Euphrasia*, *Odontites* (Orobanchaceae), *Rhinanthus alectorolophus* (Scrophulariaceae), and *Pedicularis* from Europe (Table 1) (Disque 1908; Razowski 1970; Bradley et al. 1973; Kawabe 1982; Liu and Li 2002) .

Material and methods

Rearing. Laboratory colonies were established by collecting pupae and larvae from arrowhead seeds showing symptoms of damage. The samples were taken from experimental paddy fields at the Rice Research Institute of Iran (RRII) (N 37°12′22.2″, E 049°38′40.7″, 80 m) from 2008 to 2012. Samples were collected from the third week of August to the third week of September each year. Pupae and larvae were kept in rearing containers 12 cm diameter and 24 cm in height. Each container was furnished with about 50 grams of arrowhead seeds.

After emergence males and females were moved for mating and placed in transparent plastic containers 12 cm diameter and 14 cm height that contained 50 grams of fresh arrowhead seeds. Once a female laid eggs, no additional adults were placed in the container, and the colony continued its development naturally. After two weeks about 50 grams of fresh arrowhead seeds were added to each container. Colonies were inspected daily, and all activities, including egg hatching, larval feeding period, pupation, and emergence of adults were recorded. A second generation was produced using adults of the first generation's egg masses that were transferred into mating containers. About four generations were produced each year.

Identification. Twenty samples were used for identification each year. Morphological terminology follows Razowski (1987). Preliminary identification was conducted in the RRII entomology laboratory based on wing venation (Sun and Li 2013), shape of the labial palpus, and other morphological aspects (Byun et al. 2007). Dissection of the genitalia (Fig. 2) of an adult male in the Natural History Museum of University of Oslo, confirmed the identity of the species as *Gynnidomorpha permixtana* (Denis & Schiffermüller, 1775).

Table 1. Cited from Tortricid.net, host plant data base in addition to Japanese and Chinese data.

Host plant	Plant family	Herbivore	Subfamily	Georegion	Location
Alisma plantago-aquatica L.	Alismataceae	*Gynnidomorpha alismana* (Ragonot) (as *Phalonidia*)	Tortricinae	Bradley et al. 1973	Europe
Alisma plantago-aquatica L.	Alismataceae	*Gynnidomorpha permixtana* (Denis & Schiffermueller) (as *mussehilana*)	Tortricinae	Disque 1908	Europe
Alisma plantago-aquatica L.	Alismataceae	*Gynnidomorpha permixtana* (Denis & Schiffermueller) (as *Phalonidia*)	Tortricinae	Razowski 1970; Bradley et al. 1973	Europe
Alisma plantago-aquatica L.	Alismataceae	*Gynnidomorpha vectisana* (Humphreys & Westwood) (as *geyeriana*)	Tortricinae	Disque 1908	Europe
Alisma sp.	Alismataceae	*Gynnidomorpha alismana* (Ragonot) (as *Phalonidia*)	Tortricinae	Razowski 1970; Bradley et al. 1973	Europe
Blackstonia sp	Unknown	*Gynnidomorpha rubricana* (Peyerimhoff)	Tortricinae	Trematerra and Baldizzone 2004	Europe Croatia
Butomus umbellatus L.	Butomaceae	*Gynnidomorpha permixtana* (Denis & Schiffermueller)	Tortricinae	Disque 1908; Bradley et al. 1973	Europe
Euphrasia sp.	Scrophulariaceae	*Gynnidomorpha permixtana* (Denis & Schiffermueller) (as *Phalonidia*)	Tortricinae	Razowski 1970; Bradley et al. 1973; Kawabe 1982; Liu and Li 2002	Europe, Japan and China
Gentiana lutea L.	Gentianaceae	*Gynnidomorpha permixtana* (Denis and Schiffermueller) (as *Phalonidia*)	Tortricinae	Razowski 1970; Bradley et al. 1973; Kawabe 1982; Liu and Li 2002	Europe, Japan and China
Marticaria recutita L.	Asteraceae	*Gynnidomorpha luridana* (Greyson) (as *Phalonidia*)	Tortricinae	Bradley et al. 1973	Europe
Marticaria recutita L.	Asteraceae	*Gynnidomorpha luridana* (Gregson)	Tortricinae	Trematerra and Baldizzone 2004	Europe Croatia
Menyanthes trifoliata L.	Menyanthaceae	*Gynnidomorpha minimana* (Caradja) (as *Phalonidia*)	Tortricinae	Bradley et al. 1973	Europe
Pedicularis palustris L.	Scrophulariaceae	*Gynnidomorpha minimana* (Caradja) (as *Phalonidia*)	Tortricinae	Razowski 1970; Bradley et al. 1973	Europe
Pedicularis sp.	Scrophulariaceae	*Gynnidomorpha permixtana* (Denis & Schiffermueller) (as *Phalonidia*)	Tortricinae	Razowski 1970; Bradley et al. 1973, Kawabe 1982; Liu and Li 2002	Europe, Japan and China
Plantago maritima L.	Plantaginaceae	*Gynnidomorpha vectisana* (Humphreys & Westwood) (as *Phalonidia*)	Tortricinae	Razowski 1970	Europe
Rhinanthus minor L. (as *Alectorolophus*)	Scrophulariaceae	*Gynnidomorpha permixtana* (Denis & Schiffermueller) (as *mussehilana*)	Tortricinae	Disque 1908	Europe
Rhinanthus sp.	Scrophulariaceae	*Gynnidomorpha permixtana* (Denis & Schiffermueller) (as *Phalonidia*)	Tortricinae	Razowski 1970; Bradley et al. 1973;	Europe
Salicornia sp.	Chenopodiaceae	*Gynnidomorpha vectisana* (Humphreys & Westwood) (as *Phalonidia*)	Tortricinae	Razowski 1970	Europe
Triglochin maritima L.	Juncaginaceae	*Gynnidomorpha vectisana* (Humphreys & Westwood) (as *Phalonidia*)	Tortricinae	Bradley et al. 1973	Europe

Field observation. Field studies were based on collecting by light traps, examination of arrowhead seeds and flowers that showed signs of injury, and inspection of other host plants (such as *Alisma* sp.) for characteristic signs of damage. At least three paddy fields with heavy infestations were inspected each year.

Results

Eggs. Eggs are small (ca. 0.5 mm diameter), round, white or opaque (Fig. 3), and are laid singly or in groups of 2–3 on a smooth surface of the host plant. In the laboratory, eggs hatched after an average of 3–4 days incubation at 27–31 °C. However, the incubation period may be correlated with temperature because eggs held at < 25 °C showed a conspicuous increase in the incubation period (6–9 days at 21–25 °C).

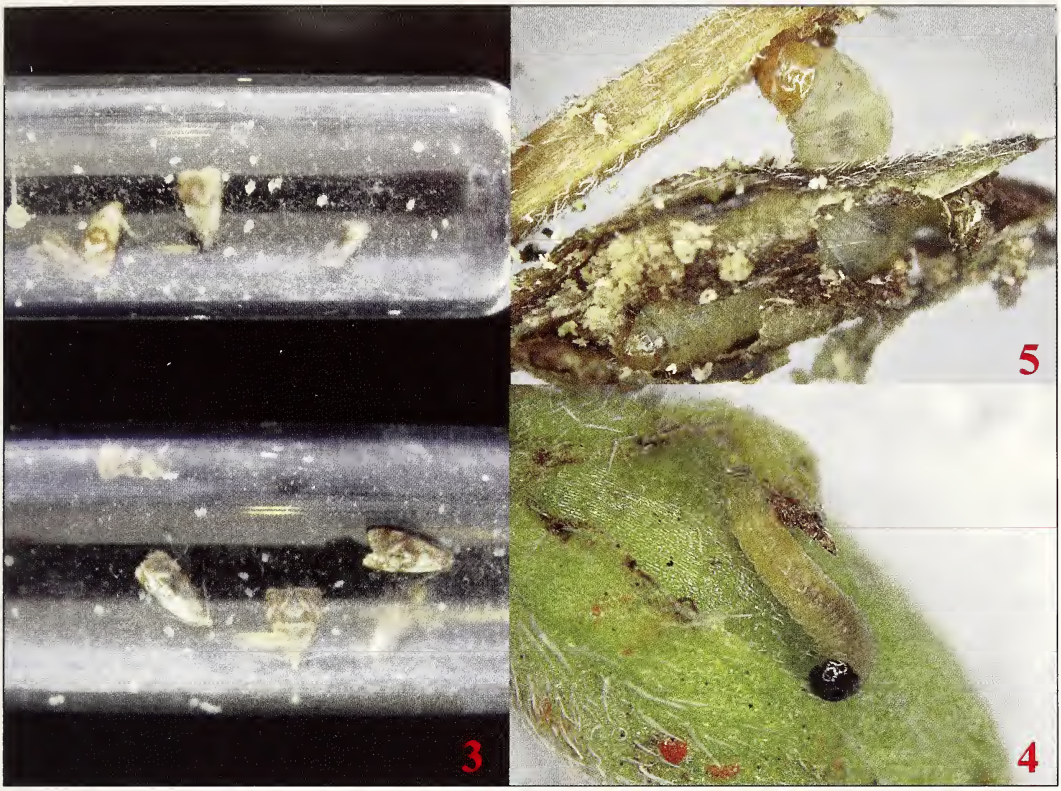
Larva. Newly hatched larvae (Fig. 4) are off-white, about 1–1.5 mm long, and have a dark brown to nearly black head. Mature larvae (Fig. 5) are 7–10 mm long, their color depending on their diet. If fed on fresh seeds, they are pale green to medium green; if fed on dry seeds they are yellow-brown to straw colored. The head is light yellow-brown, and the 1st segment (prothorax) is light greenish-brown. Larvae are figured by Beavan and Heckford 2012. In the laboratory (at 27–31 °C) larvae require 4–5 instars that last about 12–15 days. Early instars do not leave the seeds, but the later ones do, searching for food or a pupation site.

Pupa. Pupation usually occurs inside seeds of the food plant or in shelters made by larvae from other available material. Pupae (Fig. 6) are 6–7 mm long, and turn from greenish-brown to brown as they mature. In the laboratory (at 27–31 °C) the pupal period lasts 7–9 days. Upon adult eclosure, the exuvium is partly extruded from the shelter (Figs 7, 8).

Symptoms of damage on the food plant. Larvae feed on flowers and seeds of arrowhead. They disperse after hatching and tunnel through seeds. The entrance holes of the tunnels are inconspicuous; therefore initially there is no external evidence of larval feeding. After about one week the entrance holes become marked by a protruding mass of frass which has the appearance of grains of sand and silk that accumulate on the surface of the achenes (Fig. 9). One to several larvae may be present in a single fruit. Young larvae feed inside flower buds which are destroyed and hence abort. Flower buds and seeds dry up and disintegrate within about two weeks after infestation, but seeds that contain pupae and older instars remain on green flower tops (Fig. 10). In this way larvae destroy most of the achenes or cause severe injury to them. In addition, those few achenes that remain uninjured decompose after a few weeks and disintegrate because larvae spin them into silk webs together with injured seeds (Fig. 11). In some cases the remaining seed heads contain only frass and silk webs because the larvae have destroyed all achenes and their germplasm. At this stage frass and destroyed achenes form sawdust-like masses which fall to the ground.

Discussion

Numerous host plants have been recorded for Cochylini, but most of them belong to Asteraceae, and some of the Cochylini genera (e.g. *Aethes* and *Cochylis*) mainly feed on this family (Razowski 1970; Trematerra and Baldizzone 2004; Fazekas 2008; Sun and Li 2013). Worldwide, there are few host plant records for *Gynnidomorpha* spp. and the host plant of many species is unknown. However, for some species of *Gynnidomorpha*, in addition to Asteraceae, species of Alismataceae, Butomaceae, Scrophulariaceae, Gentianaceae, Menyanthaceae, Plantaginaceae, Chenopodiaceae and Juncaginaceae have been recorded as food plants (Table 1) (Disque 1908; Razowski 1970; Bradley et al. 1973). Based on literature records some of the *Gynnidomorpha* species, such as



Figures 3–5. Immature stages of *G. permixtana*. **3.** Eggs; **4.** Early instar larva; **5.** Final instar larva (Photo: **3.** A. Farahpour; **4, 5.** Beavan & Heckford).

G. alismana and *G. rubricana*, seem to be monophagous and feed on only one genus or species. Other species are oligophagous and have a range of food plants. Among them *G. permixtana* has the largest range of host plants.

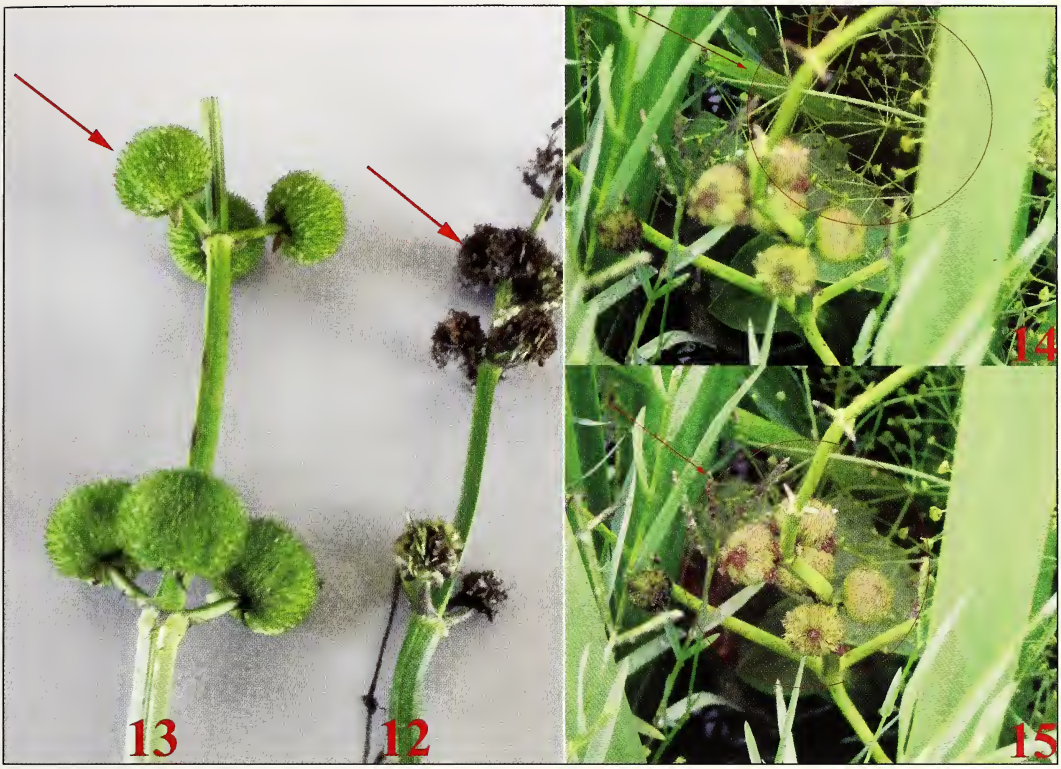
Kaltenbach (1856) stated that he had reared a *Cochylis* larva from *Sagittaria sagittifolia* L. but he did not mention the species (Beavan and Heckford 2012). In China a *Sagittaria* sp. has been reported as the food plant of *G. mesotypa* (Sun and Li 2013) but *G. mesotypa* has not been reported from Iran. Laboratory rearings confirmed that *G. permixtana* is an internal feeder of arrowhead seeds and flower buds. Westbury (2004) reported that *G. permixtana* is a seed predator of *Rhinanthus minor*; Bradley et al. (1973) stated that *G. permixtana* larvae feed in the flower heads, seeds and stems of *Rhinanthus*. Organisms that feed internally, particularly on meristematic tissues, often affect the plant more seriously (Center et al. 2002). Beavan and Heckford (2012) described *G. permixtana* behavior on *Rhinanthus minor*. They stated that each larva fed entirely within one seed-capsule and sometimes a larva would spin two seed-capsules together and apparently transfer from one to the other and there would never be more than one larva in any one capsule. They suggested that because each seed-capsule was no longer than 5 mm, at that stage each larva fed entirely within one seed-capsule. They also reported that the seed-capsules with larvae sometimes had some dark discoloration on the outside but otherwise there were no outward visible signs that they were inhabited and that full-grown larvae had habit of wandering about the containers which contained

Figures 6–8. Maturing stages of *G. permixtana*: **6.** Pupa; **7.** Newly emerged adult with partly exuded exuvium; **8.** Living adult (Photo: A. Farahpour).

Figures 9–11. Damage symptoms on food plant. **9.** About one week after hatching, arrows showing marked entrance holes; **10.** About two weeks after hatching, arrows showing dried up flower buds; **11.** About three weeks after hatching, arrows showing dried up fruits (Photo: A. Farahpour).

infested fruits. Each fruit of *Sagittaria sagittifolia* L. contained more than one larva and as already mentioned there was no visible signs of infestation in the first stage. However, after a few days symptoms of infestation became visible. Other habits, such as spinning achenes and wandering about the infested sites, were apparently the same.

Sagittaria spp. emerge at 16 °C to 17 °C (Noda 1977). Under the climatic conditions of northern Iran the activity period is from late June to late November. If there is suitable temperature and weather in November and December, they will continue their activity until late December. Results of field inspections showed that *G. permixtana* was active from the beginning of July until late November. Sun and Li (2013) and Razowski (2009) reported that in Europe the *Gynnidomorpha* species are usually bivoltine and occur in various habitats, but many of them are restricted to humid or even aquatic ones. Northern Iran is humid and paddy field has aquatic habitat so environmental



Figures 12–15. Infested fruits compared with uninfested fruits at the same age. **12.** Infested fruits; **13.** Uninfested fruits (Photo: A. Farahpour). **14–15.** *Sagittaria sagittifolia* and *Alisma* sp. seeds from same spot. **14.** *Alisma* sp. seeds without infestation symptoms; **15.** *Sagittaria sagittifolia* seeds with infestation symptoms (Photo: A. Farahpour).

conditions are suitable for this species. Also, in the laboratory as long as its food plant was available and temperature was optimal, it continued its activity. Since its food plant became limited each year during the winter, we are uncertain about its facultative diapause. However, food source and environmental conditions could affect voltinism. The synchronization between *G. permixtana* and arrowhead seems to be strong, because in 2010 when the weather was mild in November and December, this species (*G. permixtana*) continued its activity until late December. Close synchrony between an insect and the resource dynamics of its host can lead to increased insect densities, whereas consequences of asynchronization between insect and plant include reduced insect density (Turgeon 1986). In addition to various bottom-up effects, the synchronization of herbivores with their host plant phenology determines quality and quantity of food resources and affects the preference–performance linkage and abundance of herbivores (Yukawa 2000). Therefore, this close synchronization with host plant could be an important and beneficial factor for *G. permixtana*.

When injured seeds of infested fruits (Fig. 12) were inspected in the laboratory and compared with uninfested fruits (Fig. 13), physical damage caused by larval feeding was severe. Since fruits consist of multiple achenes, each larva is capable of destroying more than one seed. Seeds are partially or completely consumed. Furthermore, as feeding progresses, the seeds become bound together with coarse frass and webbing. In arrowheads, sexual reproduction via seeds is better for

establishing new populations because of their small size and ability to disperse. Being small and buoyant, the seeds are capable of 'rafting' to suitable sites on relatively light currents, gathering in still pools and river bends. This mechanism can bring about the redistribution of genes along and among waterways (Broadhurst and Chong 2011). When they are bound together they are unable to raft and/or disperse.

We were unable to find symptoms of damage and biology of *G. permixtana* on other food plants such as *Alisma* sp. Despite the fact that *Alisma* is common in the investigated fields (Fig. 14), we could not find any trace of *G. permixtana* activity on that plant (Fig. 15), and all our attempts to rear a generation on other food plants in the laboratory failed.

The importance of plant-feeding insects in the dynamics of aquatic and wetland ecosystems is often unappreciated. This is most often due to the unfamiliarity of resource managers, scientists, and others with the plant-feeding insects that are present in these ecosystems. The purpose of this study was mainly to facilitate the recognition of *G. permixtana*, and review its biology and the symptoms of damage that it causes on arrowhead and therefore statistical methods were not employed. Determination of beneficial factors of *G. permixtana* as a biological control agent needs more biological and statistical studies. The information that we discovered about this species may represent an important step in this direction.

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Taxonomic comments on the treatment of the Zygaenidae (Lepidoptera) in volume 3 of *Moths of Europe*, Zygaenids, Pyralids 1 and Brachodids (2012)

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Abstract. Critical taxonomic comments are provided on the section dealing with the Zygaenidae in volume 3 of *Moths of Europe* (Leraut 2012). A number of newly described nominal taxa in that work are here synonymised as are nominal subgenera and subspecies that were reinstated as valid. At the subgeneric level these are *Hesychia* Hübner, [1819] (**syn. rev.**), *Coelestis* Burgeff, 1926 (**syn. rev.**) and *Santolinophaga* Burgeff, 1926 (**syn. rev.**), all synonyms of the monophyletic subgenus *Mesembrynus* Hübner, [1819], and *Coelestina* Holik, 1953 (**syn. rev.**), *Epizygaena* Jordan, 1907 (**syn. rev.**) and *Lictoria* Burgeff, 1926 (**syn. rev.**), all synonyms of the paraphyletic subgenus *Agrumenia* Hübner, [1819]. At the subspecific level *Adscita geryon parisiensis* Leraut, 2012 (**syn. n.**) and *A. geryon aeris* (Verity, 1946) (**syn. rev.**) are synonyms of *A. geryon geryon* (Hübner, [1813]). *Zygaena exulans altaretensis* Le Charles, 1942 (**syn. rev.**) and *Z. exulans bourgognei* Le Charles, 1942 (**syn. rev.**) are synonyms of *Z. exulans exulans* (Hohenwarth, 1792). *Zygaena trifolii vindilisensis* Leraut, 2012 (**syn. n.**) is a synonym of *Z. trifolii subsyracusia* Verity, 1925. *Zygaena carniolica besseensis* Leraut, 2012 (**syn. n.**) and *Z. carniolica rogervillensis* Leraut, 2012 (**syn. n.**) are synonyms of *Z. carniolica modesta* Burgeff, 1914. *Zygaena hilaris nigriventris* Leraut, 2012 (**syn. n.**) is a synonym of *Z. hilaris chrysophaea* Le Charles, [1934]. *Zygaena rhadamanthus boixolsis* Aistleitner, 1990 (**syn. n.**) is a synonym of *Z. rhadamanthus rhadamanthus* Esper, [1789], *Z. rhadamanthus cleui* Dujardin, 1956 (**syn. rev.**) is a synonym of *Z. rhadamanthus grisea* Oberthür, 1909, and *Z. rhadamanthus aragonia* Tremewan, 1961 (**stat. rev.**), *Z. rhadamanthus azurea* Burgeff, 1914 (**stat. rev.**) and *Z. rhadamanthus aurargentea* Mazel, 1979 (**stat. rev.**) are reinstated as valid subspecies.

Résumé. Les auteurs font une analyse critique de la taxonomie employée pour le chapitre traitant des Zygaenidae, dans le volume 3 de la série «papillons de nuit d'Europe». Un certain nombre de taxons nominaux nouvellement décrits sont mis en synonymie, ainsi que des sous-genres et sous-espèces qui avaient été considérés comme valides. Au niveau subgénérique c'est le cas pour *Hesychia* Hübner, [1819] (**syn. rev.**), *Coelestis* Burgeff, 1926 (**syn. rev.**) et *Santolinophaga* Burgeff, 1926 (**syn. rev.**), qui doivent être replacés dans le sous-genre monophylétique *Mesembrynus* Hübner, [1819] et *Coelestina* Holik, 1953 (**syn. rev.**), *Epizygaena* Jordan, 1907 (**syn. rev.**) et *Lictoria* Burgeff, 1926 (**syn. rev.**), qui doivent eux être placés dans le sous-genre paraphylétique *Agrumenia* Hübner, [1819]. Pour ce qui concerne les sous-espèces, il s'agit de *Adscita geryon*

parisiensis Leraut, 2012 (**syn. n.**) et *A. geryon aeris* (Verity, 1946) (**syn. n.**), qui doivent être rattachés à *A. geryon geryon* (Hübner, [1813]); *Z. exulans altaretensis* Le Charles, 1942 (**syn. rev.**) et *Z. exulans bourgognei* Le Charles, 1942 (**syn. rev.**) synonymes de *Z. exulans exulans* (Hohenwarth, 1792); *Z. trifolii vindilisensis* Leraut, 2012 (**syn. n.**) synonyme de *Z. trifolii subsyracusia* Verity, 1925; *Z. carniolica besseensis* Leraut, 2012 (**syn. n.**) et *Z. carniolica rogervillensis* Leraut, 2012 (**syn. n.**) synonymes de *Z. carniolica modesta* Burgeff, 1914; *Z. hilaris nigriventris* Leraut, 2012 (**syn. n.**) synonyme de *Z. hilaris chrysophaea* Le Charles, [1934]; enfin *Z. rhadamanthus boixolsis* Aistleitner, 1990 (**syn. n.**) synonyme de *Z. rhadamanthus rhadamanthus* (Esper, [1789]), *Z. rhadamanthus cleui* Dujardin, 1956 (**syn. rev.**) synonyme de *Z. rhadamanthus grisea* Oberthür, 1909. *Zygaena rhadamanthus aragonia* Tremewan, 1961 (**stat. rev.**), *Z. rhadamanthus azurea* Burgeff, 1914 (**stat. rev.**) et *Z. rhadamanthus aurargentea* Mazel, 1979 (**stat. rev.**), sont réintégrées comme sous-espèces valides.

Introduction

In a recent review of the Zygaenidae of Europe (Leraut 2012), a number of questionable taxonomic changes were proposed, many of which lack convincing morphological and/or phylogenetic support (Efetov et al. 2013). For example, a number of subgenera within the genus *Zygaena* were unjustifiably reinstated as valid, as were a number of taxa at subspecific level. Moreover, five subspecies and several infrasubspecific forms were newly described, but only the former are dealt with in the present paper, as infrasubspecific forms have no status under the *International Code of Zoological Nomenclature* (ICZN 1999). In order to obtain a clear understanding of the problem, it is recommended that the review (Efetov et al. 2013) of the handbook and the present article are read together.

Phaudidae

Although treated as a subfamily of the Zygaenidae by Leraut (2012: 44), the Phaudidae were elevated to full family status within the Zygaenoidea by Niehuis et al. (2006: 822, fig. 3), a placement that is now widely accepted by lepidopterists (van Nieukerken et al. 2011) and fully supported by the present authors.

Procridinae

Genus. *Zygaenoprocris* Hampson, 1900, is considered to be a valid genus (Efetov 2001a). However, Leraut (2012: 67) referred to *Zygaenoprocris taftana* (Alberti, 1939) as *Adscita taftana* (Alberti, 1939).

Subspecies. Four subspecies of *Adscita geryon* are currently recognized as valid, viz. *A. geryon geryon* (Hübner, [1813]), *A. geryon chrysocephala* (Nickerl, 1845), *A. geryon acutafibra* Verity, 1946, and *A. geryon orientalis* (Alberti, 1938) (Efetov 2001b: 128, 2001c: 155, 2004: 23). However, it is intended to place *A. geryon chrysocephala* (Efetov and Tarmann in prep.), which Leraut (2012: 62) also recognized as valid, as a synonym of *A. geryon geryon*, while the status of *A. geryon acutafibra* is at present unclear.

Adscita (*Adscita*) *geryon geryon* (Hübner, [1813])

Sphinx geryon Hübner, [1813], Sammlung europäischer Schmetterlinge 2: pl. 28, figs 130, 131. Type-locality. Europe [Germany].

Adscita geryon razza *aeris* Verity, 1946, Redia 31: 154. Type-locality. France: [Alpes-Maritimes], Saint-Barnabé. **Syn. rev.**

Adscita geryon parisiensis Leraut, 2012, Moths of Europe 3: 62, pl. 6, figs 17, 18. Type-locality. France: Paris region. **Syn. n.**

Distribution and taxonomic notes. *Adscita geryon geryon* is distributed from the Iberian Peninsula and Britain to European Russia, the Crimea and Turkey. Leraut (2012: 61) reinstated the nominal taxon *A. geryon aeris* (Verity, 1946) as valid and on the following page newly described a subspecies from the Paris region. It is acknowledged that *A. geryon* is an extremely variable species, both in phenotype and genitalic morphology, but we see no justification for recalling a subspecies from synonymy, where it was placed by Efetov and Tarmann (1999: 28, 2012: 31), or in describing a new subspecies from France. Accordingly, both taxa are here formally placed as synonyms (**syn. rev.**; **syn. n.**) of the nominotypical subspecies *A. geryon geryon*.

Zygaeninae

Subgenera. In discussing the classification of the genus *Zygaena* Fabricius, 1775, at the subgeneric level, Leraut (2012: 67–68) refers to a paper by Niehuis et al. (2006) in which the subgenera are not mentioned. Presumably the intention was to refer to the evolutionary history of the genus, as based on nuclear and mitochondrial DNA-sequencing by Niehuis et al. (2007). The latter paper provides a phylogeny in which the *Zygaena* species are placed into species-groups within three subgenera, viz. *Mesembrynus* Hübner, [1819], *Agrumenia* Hübner, [1819], and *Zygaena* Fabricius, 1775, based on the classification of Alberti (1958, 1959) and, supported by their own research, followed by Naumann and Tremewan (1984) and Hofmann and Tremewan (1996, 2010). However, Leraut (2012: 67–68) resurrected various nominal subgenera from synonymy and applied them to some of the species groups, viz. *Hesychia* Hübner, [1819], *Coelestis* Burgeff, 1926, *Santolinophaga* Burgeff, 1926, all formerly placed as synonyms of the monophyletic subgenus *Mesembrynus* Hübner, [1819], and *Coelestina* Holik, 1935, *Epizygaena* Jordan, [1907], and *Lictoria* Burgeff, 1926, all formerly placed as synonyms of *Agrumenia* Hübner, [1819] (Hofmann and Tremewan 2010). It is accepted that the subgenera *Agrumenia* and *Zygaena* are paraphyletic, but *Mesembrynus* is monophyletic, based on morphology (Alberti 1958, 1959), larval host-plants (Hofmann and Tremewan 1996) and DNA analysis (Niehuis et al. 2007). Therefore, to split the last-mentioned subgenus into four subgenera is illogical and artificial, as two (*Mesembrynus* and *Santolinophaga*) will then become paraphyletic groupings. As a consequence, the nominal subgeneric taxa *Hesychia*, *Santolinophaga* and *Coelestis* are here formally reinstated as synonyms (**syn. rev.**) of *Mesembrynus*, and *Epizygaena*, *Coelestina* and *Lictoria* are reinstated as synonyms (**syn. rev.**) of *Agrumenia*. The full synonymy of the subgenera can be found in Hofmann and Tremewan (1996, 2010) and only those relevant to Leraut (2012) are discussed below.

Subgenus *MESEMBRYNUS* Hübner, [1819]

Mesembrynus Hübner, [1819], Verzeichniss bekannter Schmettlinge: 119. Type-species: *Zygaena pluto* Ochsenheimer, 1808, by subsequent designation, Tremewan, 1961, The Entomologist's Record and Journal of Variation 73: 202.

Hesychia Hübner, [1819], Verzeichniss bekannter Schmettlinge: 116. Type-species: *Sphinx laeta* Hübner, 1790, by subsequent designation, Holik & Sheljuzhko, 1953, Mitteilungen der Münchener Entomologischen Gesellschaft 43: 219. **Syn. rev.**

Santolinophaga Burgeff, 1926, in Strand, Lepidopterorum Catalogus 4 (33): 18. Type-species: *Zygaena corsica* Boisduval, [1828], by monotypy. **Syn. rev.**

Coelestis Burgeff, 1926, in Strand, Lepidopterorum Catalogus 4 (33): 29. Type-species: *Zygaena cuvieri* Boisduval, [1828], by subsequent designation, Tremewan, 1961, The Entomologist's Record and Journal of Variation 73: 201. **Syn. rev.**

Subgenus *AGRUMENIA* Hübner, [1819]

Agrumenia Hübner, [1819], Verzeichniss bekannter Schmettlinge: 116. Type-species: *Sphinx onobrychis* [Denis & Schiffermüller], 1775, by subsequent designation, Tremewan, 1961, The Entomologist's Record and Journal of Variation 73: 202.

Epizygaena Jordan, [1907], in Seitz, Die Gross-Schmetterlinge der Erde 2: 31. Type-species: *Zygaena afghana* Moore, [1860], by subsequent designation, Fletcher, 1925, Catalogue of Indian Insects part 9: 21. **Syn. rev.**

Coelestina Holik, 1953, Entomologische Zeitschrift 63: 15. Type-species: *Zygaena sedi* Fabricius, 1787, by original designation. **Syn. rev.**

Lictoria Burgeff, 1926, in Strand, Lepidopterorum Catalogus 4 (33): 20. Type-species: *Sphinx achilleae* Esper, 1780, by subsequent designation, Holik, 1938, Entomologische Rundschau 55: 352. **Syn. rev.**

Subspecies. In their systematic catalogue of the Zygaeninae, Hofmann and Tremewan (1996) attempted to provide a classification in which some rationale could be brought to the genus *Zygaena* Fabricius, 1777, with reference to subspecies; hence an enormous number of subspecific taxa were placed as synonyms. It would appear that the classification in that catalogue has largely been ignored, as Leraut reinstated two subspecific taxa as valid and newly described four within *Zygaena*. While this would have been acceptable during the first half of the 20th century, the description of new subspecies in the genus *Zygaena* from mainland Europe at the present time neither reflects current thinking nor the presently accepted concept of a subspecies and is reminiscent of the taxonomy practised in the 1920s and 1930s (e.g. Verity (1925, 1926) described and named three 'subspecies' of *Z. trifolii* from England, based on single colonies). Mayr (1969: 41) contended that a subspecies is 'an aggregate of phenotypically similar populations of a species, inhabiting a geographic subdivision of the range of a species, and differing taxonomically from other populations of the species' and that it may consist of many local populations all of which, though very similar, are slightly different from each other genetically and phenotypically. In contrast to the reinstatement of two subspecies, Leraut (2012) synonymised four without providing justification. All of these nominal subspecific taxa are discussed in detail below. As with the subgenera, the full synonymy of the subspecies can be found in Hofmann and Tremewan (1996) and only those relevant to the field guide (Leraut 2012) are listed below.

Zygaena (*Agrumenia*) *exulans exulans* (Hohenwarth, 1792)

Sphinx exulans Hohenwarth, 1792, in Reiner & Hohenwarth, Botanische Reisen nach einigen Oberkärntnerischen und benachbarten Alpen ... : 265, pl. 6, fig. 2. Type-locality. Austria: Kärnten, Gross-Glockner, Pasterzen Kees ('an den äussersten Alpengipfeln des Eisgebirges am Glockner, auf der sogenannten Pasterze').

Zygaena exulans altaretensis Le Charles, 1942, Bulletin de la Société Entomologique de France 47: 178, pl. 1, figs A–C (Zygaena). Type-locality. France: Hautes-Alpes, Col du Lautaret, 1,800–2,200 m. [Paratype 1 ♂ examined.] **Syn. rev.**

Zygaena exulans bourgognei Le Charles, 1942, Bulletin de la Société Entomologique de France 47: 180 (Zygaena). Type-locality. France: Alpes-Maritimes, Haute Vésubie, Vallon de la Madonna de Finestre (Madone de Fénestre). **Syn. rev.**

Distribution and taxonomic notes. The nominotypical *Zygaena exulans exulans* is widely distributed throughout the European Alps. While it is acknowledged that variation does occur among some of the populations occurring in this mountain system, we see no justification for recognising any as valid nominal subspecies. When compiling the systematic catalogue (Hofmann and Tremewan 1996) it was decided that the most rational approach to subspecies in *Z. exulans* was to recognise only one subspecies in each major mountain range. Leraut (2012: 120) reinstated *Zygaena exulans altaretensis* and *Zygaena exulans bourgognei* as valid subspecies without providing justification; both are here formally placed as synonyms (**syn. rev.**) of the nominotypical *Zygaena exulans exulans*.

Zygaena (*Agrumenia*) *hilaris chrysophaea* Le Charles, [1934]

Zygaena hilaris chrysophaea Le Charles, [1934], in Lhomme, Catalogue des Lépidoptères de France et de Belgique 1: 683 (Zygaena). Type-locality. France: Alpes-de-Haute-Provence (Basses-Alpes), Digne, Fontgaillard, 1,000 m.

Zygaena hilaris nigriventris Leraut, 2012, Moths of Europe 3: 115, pl. 32, figs 20, 21, pl. 33, fig. 1. Type-locality. France: Hautes-Alpes, La Bessée-sur-Durance. **Syn. n.**

Distribution and taxonomic notes. In the original description of *Zygaena hilaris nigriventris* it is stated, 'This subspecies can be distinguished from subsp. *apocrypha* Le Charles from the area around Nice essentially by the abdomen with its black ventral side and absence of whitish rings. Also wingspan is greater on average.' This taxon differs greatly from the nominal taxon *apocrypha*, as this was described as a subspecies of and is conspecific with *Z. fausta* from the Alpes-de-Haute-Provence; currently it is placed as a synonym of *Z. fausta fausta* (Linnaeus, 1767) (Hofmann and Tremewan 1996: 103). Leraut (2012) most likely confused the names *apocrypha* and *chrysophaea*, the latter taxon being a subspecies of *Z. hilaris*.

Zygaena hilaris chrysophaea has a wide distribution in France, ranging from Vaucluse, Alpes-de-Haute-Provence, Drôme and Hautes-Alpes to Isère. To describe a subspecific taxon from within that distributional range cannot be justified; therefore, *Zygaena hilaris nigriventris* is here formally placed as a synonym (**syn. n.**) of *Zygaena hilaris chrysophaea*.

Zygaena (*Agrumenia*) *carniolica modesta* Burgeff, 1914

Zygaena carniolica modesta Burgeff, 1914, Mitteilungen der Münchener Entomologischen Gesellschaft 5: 57, pl. 3, figs 99, 100, 106, 107. Type-locality. Germany: Rheinland-Pfalz, central and lower Rheintal from Mainz to Koblenz.

Zygaena carniolica rogervillensis Leraut, 2012, Moths of Europe 3: 108, pl. 28, figs 16, 17. Type-locality. France: Seine-Maritime, Rogerville. **Syn. n.**

Zygaena carniolica besseensis Leraut, 2012, Moths of Europe 3: 110, pl. 29, figs 1–3. Type-locality. France: Puy-de-Dôme, Besse-en-Chandesse. **Syn. n.**

Distribution and taxonomic notes. *Zygaena carniolica modesta* has a wide distribution that ranges from northern and central France, through Belgium, Luxembourg, central and southern Germany to northern Austria, Czech Republic and southern Poland. We see no justification for describing two new subspecies from single localities located within this distribution, as their phenotypes fall within the range of variation; therefore, *Zygaena carniolica rogervillensis* and *Zygaena carniolica besseensis* are here formally placed as synonyms (**syn. n.**) of *Zygaena carniolica modesta.*

Zygaena (*Zygaena*) *rhadamanthus* (Esper, [1789])

Sphinx rhadamanthus Esper, [1789], Die Schmetterlinge in Abbildungen nach der Natur mit Beschreibungen 2 (Supplement): pl. 40, figs 1, 2; 1794, ibidem 2: 13. Type-locality. France: Gard (Languedoc), Nîmes.

Remarks. In stark contrast to the splitting and naming of geographical populations of other *Zygaena* species, Leraut (2012: 98) lumps together a number of subspecific taxa of *Z. rhadamanthus* (Esper, [1789]), all but one of which were considered valid by Hofmann and Tremewan (1996: 130–131). The latter authors accept that less variation is exhibited in the populations occurring in France (east of the Pyrenees) compared to those in the Iberian Peninsula where they exhibit a mosaic of extreme geographical variation, with phenotypes ranging from 'normal' and melanistic to individuals with the forewing ground colour powdered with white scales (griseoid) and reminiscent of *Zygaena rhadamanthus grisea.* The subspecific nominal taxa relevant to their treatment by Leraut (2012: 98) are discussed in detail below.

Zygaena (*Zygaena*) *rhadamanthus grisea* Oberthür, 1909

Zygaena rhadamanthus grisea Oberthür, 1909, Etudes de Lépidoptérologie comparée 3: 414, pl. 29, fig. 187. Type-locality. France: Alpes-de-Haute-Provence (Basses-Alpes), Digne.

Zygaena rhadamanthus cleui Dujardin, 1956, Bulletin mensuel de la Société Linnéenne de Lyon 25: 261 (Zygaena). Type-locality. France: Ardèche, St-Privat. [Paratypes 1 ♂, 1 ♀ examined.] **Syn. rev.**

Distribution and taxonomic notes. *Zygaena rhadamanthus grisea* has a wide distribution in south-eastern and southern-central France, ranging from Alpes-de-Haute-Provence and Hautes-Alpes to Isère, Drôme, Ardèche, Vaucluse, Aveyron, Lot and Lozère. Based on phenotype (and geography – *Z. rhadamanthus cleui* cannot be recognised as valid because its location is within the distributional range of *Z. rhadamanthus grisea*), we see no justification for Leraut's (2012: 98) reinstatement of *Zygaena rhadamanthus cleui* as a valid subspecies under which he placed *Zygaena rhadamanthus aragonia* and *Zygaena rhadamanthus aurargentea* as synonyms (see also below). Even in the original description, Dujardin compared *Zygaena rhadamanthus cleui* with *Z. rhadamanthus grisea*, stating that the forewing ground colour was similar. Consequently, it is here reinstated as a synonym (**syn. rev.**) of *Zygaena rhadamanthus grisea*, as placed by Hofmann and Tremewan (1996: 131).

Zygaena (*Zygaena*) *rhadamanthus azurea* Burgeff, 1914, stat. rev.

Zygaena rhadamanthus azurea Burgeff, 1914, Mitteilungen der Münchener Entomologischen Gesellschaft 5: 60, pl. 2, fig. 158, pl. 6, figs 75, 76 (Zygaena). Type-locality. France: Alpes-Maritimes (excluding coastal regions).

Distribution and taxonomic notes. *Zygaena rhadamanthus azurea* is distributed in the départements of Var and Alpes-Maritimes (excluding coastal regions). Although Leraut (2012: 98) synonymised this taxon with the melanistic *Zygaena rhadamanthus stygia* Burgeff, 1914, the distribution of the latter ranges from east of the River Var (Alpes-Maritimes) in France to Imperia in Italy. Much has been written about littoral melanism (e.g. Burgeff 1951, 1956, 1965; Dujardin 1965: 586–587) and that exhibited by subsp. *stygia* is a good example for comparison with the 'normal' phenotype of subsp. *azurea* – to consider both taxa as one subspecies clearly disregards the concept of littoral melanism and the zoogeography of *Z. rhadamanthus* in south-eastern France. Consequently, *Zygaena rhadamanthus azurea* is here reinstated as a valid subspecies (**stat. rev.**).

Zygaena (*Zygaena*) *rhadamanthus rhadamanthus* (Esper, [1789])

Sphinx rhadamanthus Esper, [1789], Die Schmetterlinge in Abbildungen nach der Natur mit Beschreibungen 2 (Supplement): pl. 40, figs 1, 2; 1794, ibidem 2: 13. Type-locality. France: Gard (Languedoc), Nîmes.

Zygaena rhadamanthus pyrenaea Verity, 1920, The Entomologist's Record and Journal of Variation 32: 161 (Zygaena). Type-locality. France: Pyrénées-Orientales, between Prades and Mont Canigou, La Trancada d'Ambouilla.

Zygaena rhadamanthus boixolsis Aistleitner, 1990, Nachrichten des Entomologischen Vereins Apollo (N.F.) 11: 79. Type-locality. Spain: Lérida, Collado de Boixols, 1,300–1,400 m. [Paratypes 4 ♂, 4; Topotypes 4 ♂, 1 ♀ examined.] **Syn. n.**

Distribution and taxonomic notes. Based on a description by Oberthür (1910: 591), Verity provided the name *pyrenaea* for the population of *Zygaena rhadamanthus* occurring at La Trancada d'Ambouilla (Pyrénées-Orientales, between Prades and Mont Canigou). Leraut (2012: 98) considered this taxon to be a 'simple synonym' of the nominotypical *Zygaena rhadamanthus rhadamanthus*, a placement with which we agree even though Hofmann and Tremewan (1996: 131) had considered it to be a valid subspecies with which the taxon *Zygaena rhadamanthus boixolsis* Aistleitner, 1990, had been placed as a synonym. The latter is now automatically transferred as a synonym of the nominotypical subspecies. Specimens from La Trancada d'Ambouilla lack the white scaling (griseoid) on the ground colour of the forewings; moreover, a red abdominal cingulum is absent, as found in the nominotypical subspecies.

Zygaena (*Zygaena*) *rhadamanthus aurargentea* Mazel, 1979, stat. rev.

Zygaena rhadamanthus aurargentea Mazel, 1979, Entomops, Nice 6: 267, figs 1, 2 (Zygaena). Type-locality. France: Pyrénées-Orientales, Coustouges.

Distribution and taxonomic notes. Described from Coustouges (Pyrénées-Orientales, France), *Zygaena rhadamanthus aurargentea* is also found in Spain (Barcelona and Gerona, excluding coastal regions). It is distinguished from *Zygaena rhadamanthus rhadamanthus* by the extreme griseoid phenotype, i.e. with pronounced white scaling on the ground colour of the forewings,

especially in the females, which is reminiscent of *Zygaena rhadamanthus grisea* from south-eastern and southern-central France (see above), and by the presence of a strong abdominal cingulum that is also present ventrally. Leraut (2012: 98) placed *Zygaena rhadamanthus aurargentea* as a synonym of *Zygaena rhadamanthus cleui*, which he reinstated as a valid subspecies, but we see no justification for this (see also above). The former is here reinstated (**stat. rev.**) as a valid subspecies, based on its extreme phenotype, which is so strongly different from that of the nominotypical taxon *Z. rhadamanthus rhadamanthus* (Hofmann and Tremewan 1996: 131).

Zygaena (*Zygaena*) *rhadamanthus aragonia* Tremewan, 1961, stat. rev.

Zygaena rhadamanthus aragonia Tremewan, 1961, The Entomologist's Record and Journal of Variation 73: 4. Type-locality. Spain: Teruel, Albarracín. [Holotype ♂, paratypes 16 ♂, 11 ♀ examined.]

Distribution and taxonomic notes. *Zygaena rhadamanthus aragonia* is distributed in the Spanish provinces of Cuenca and Teruel. While it is reminiscent of *Zygaena rhadamanthus grisea* from south-eastern and southern-central France, the placement of this taxon as a synonym of *Zygaena rhadamanthus cleui* by Leraut (2012: 98), which he reinstated as a valid subspecies, is inconsistent with the geographical distribution, its 'griseoid' phenotype and the presence of a strong abdominal cingulum. As a consequence, *Zygaena rhadamanthus aragonia* is here reinstated (**stat. rev.**) as a valid subspecies (Hofmann and Tremewan 1996: 130). It should be noted that *Zygaena rhadamanthus aurargentea* also has a griseoid phenotype and a strong abdominal cingulum, but the two taxa are geographically separated by a large lowland area that includes the River Ebro.

Zygaena (*Zygaena*) *trifolii subsyracusia* Verity, 1925

Zygaena trifolii subsyracusia Verity, 1925, The Entomologist's Record and Journal of Variation 37: 117, pl. 8, figs 31–33 (Zygaena); 1926, ibidem 38: 25 (Zygaena). Type-locality. France: Morbihan, Plouharnel; Channel Islands.

Zygaena trifolii vindilisensis Leraut, 2012, Moths of Europe 3: 87, pl. 14, figs 20, 21. Type-locality. France: Morbihan, Belle-Ile-en-Mer. **Syn. n.**

Distribution and taxonomic notes. *Zygaena trifolii* varies in phenotype from year to year, even within the same colony (A. Hofmann and W. G. Tremewan pers. obs.). Hence, specimens taken from the same island (Belle-Ile-en-Mer) in different years may not match the original description (E. Drouet pers. comm.). On this basis, *Zygaena trifolii vindilisensis* is synonymised (**syn. n.**) with *Zygaena trifolii subsyracusia*, a subspecies that is distributed along the coastal regions of north-western France, from Loire-Atlantique to Côtes-d'Armor and Ille-et-Villaine, and is also found in the Channel Islands (Hofmann and Tremewan 1996: 185).

General taxonomic comments

Leraut (2012: 67) stated that the phylogenetic sequence in the presentation of the species follows Niehuis et al. (2007), yet the sister species *Z. trifolii* and *Z. lonicerae* are divided by

Z. filipendulae; the first two species are more closely related to each other than either is to *Z. filipendulae* and together they form a sister group to the latter (Niehuis et al. 2007; Hofmann and Tremewan 2010: 123).

The position (Leraut 2012: 68) of *Z. persephone* in the 'subgenus' *Santolinophaga* (a synonym of *Mesembrynus*, as discussed above) is also incorrect. While we are aware that the systematic position of *Z. persephone* is at present enigmatic, we cannot see any justification for placing a species whose larva feeds on *Vicia glauca* C. Presl. (Fabaceae) (Barragué 1986: 316; Tremewan 1989) in a monophyletic subgenus consisting solely of Apiaceae-, Asteraceae- and Lamiaceae-feeders. No doubt Leraut had difficulty assigning it to a subgenus because it was not dealt with by Niehuis et al. (2007). However, until the taxon has been subjected to DNA analysis, it is better to keep the status quo, i.e. to leave it in the subgenus *Zygaena*, following Alberti (1958: 280, 313), Naumann and Tremewan (1984: 168) and Hofmann and Tremewan (1996: 142, 2010: 123).

While it is correctly stated (Leraut 2012: 100) that *Z. oxytropis* is closely similar to *Z. rhadamanthus*, there is little evidence that the former could only be a subspecies of the latter and that 'molecular biology' could be used to investigate further. In spite of the fact that a hybrid zone between the taxa occurs (or occurred) in north-western Italy (Burgeff 1951: 11), a phenomenon that is not unusual between the ranges of two closely related *Zygaena* species, the heterospecificity of *Z. oxytropis* and *Z. rhadamanthus* has been confirmed by DNA analysis (Niehuis et al. 2007).

With reference to the treatment of *Z. transalpina transalpina* and *Z. transalpina hippocrepidis* (Leraut 2012: 102–106), one has to acknowledge that the relationship between these two taxa has been controversial for many years. Leraut (2012) followed the intensive study by Mazel (2009a, 2009b, 2010) who contends that the genitalic morphology has 'confirmed' that both taxa are valid species and that a hybrid zone between the two taxa occurs in eastern France. However, while Mazel should be acknowledged for the enormous amount of research into the problem, his arguments based on genitalic morphology alone are unconvincing. It should be noted that there are also hybrid populations in Germany where they form a mosaic in their distribution rather than a hybrid zone or tension zone (Hofmann 1994: 285–288). Moreover, DNA analysis by Niehuis et al. (2007) supports their conspecificity, as does the work of Hille (2012) who has recently assessed populations by using genogeographic clustering, based on phenotype, genotype and haplotype variation. New molecular data provided by Hille, based on 200 specimens from Germany, Austria, Slovenia, Croatia, Czech Republic and Slovakia, augment the sequence data base available for this approach. Further support has been provided by a Bayesian phylogenetic analysis (von Reumont et al. 2012: 45, fig. 4).

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New data on the many-plumed moths (Alucitidae, Lepidoptera) of the Far East of Russia

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Abstract. *Orneodes zonodactyla* var. *eumorphodactyla* Caradja, 1920 is regarded as a valid species with the following combination: *Pterotopteryx eumorphodactyla* (Caradja, 1920), comb.nov. *Alucita sakhalinica* Zagulajev, 1995 and *Pterotopteryx koreana* Bong-Kyu Byun, 2006, are synonymized with *Pterotopteryx eumorphodactyla* (Caradja, 1920). New data on the distribution of *P. eumorphodactyla* and *Alucita ussurica* Ustjuzhanin, 1999 in the Russian Far East are given.

Introduction

The Alucitidae comprise 216 species in 9 genera distributed around the world (van Nieukerken et al. 2011). The first Russian Far East representative of Alucitidae was described by Prince Aristide Caradja from the neighborhood of Radde Village as *Orneodes zonodactyla* var. *eumorphodactyla* Caradja, 1920. It was given species status as *Alucita eumorphodactyla* (Caradja, 1920) by Gielis (2003). The species was not listed in the Alucitidae chapter of the "Key to the Insects of the Russian Far East" (Ustjuzhanin 1999b), but it was included as *Alucita eumorphodactyla* in the "Catalogue of the Lepidoptera of Russia" (Ustjuzhanin and Kovtunovich 2008).

Pterotopteryx sakhalinica (Zagulajev, 1995) was described from the southern part of Sakhalin Island based on a series of 10 specimens (Zagulajev 1995). Later, we found that this species had a rather wide range, occurring not only on Sakhalin, but also in the southern Kurile Islands and the continental part of the Russian Far East, from Khasan District in the south to Nikolayevsk-on-Amur in the north (Ustjuzhanin and Kovtunovich 2008). More recently, Ustjuzhanin (1999a) described *Alucita ussurica* Ustjuzhanin, 1999 from the southern part of Primorsky Krai, currently its only known locality.

Five species of Alucitidae were reported from Japan (Hashimoto 1984). Two of them, *Alucita japonica* (Matsumura, 1931) and *Pterotopteryx spilodesma* (Meyrick, 1907), inhabit Hokkaido Island, the nearest territory to the Russian Far East. Both can be easily distinguished from *Alucita ussurica* and *Pterotopteryx eumorphodactyla* based on external characters and genitalia morphology. Three species have been recorded from Korea (Byun 2006): *Alucita japonica*, *Pterotopteryx spilodesma*, and the newly described *Pterotopteryx koreana* Byun, 2006.

Our re-examination of type specimens and study of additional material allow us to make some corrections and additions to the taxonomy and distribution of the Alucitidae species found in the Russian Far East.

Abbreviations

MGAB Grigore Antipa National Museum of Natural History (Bucharest, Romania).

ISEA Institute of Systematics and Ecology of Animals (Novosibirsk, Russia).

CUK Collection of P. Ustjuzhanin and V. Kovtunovich (Novosibirsk and Moscow, Russia).

ZISP Zoological Institute (St. Petersburg, Russia).

Taxonomic part

Pterotopteryx eumorphodactyla (Caradja, 1920), comb. n.

Figs 1–6

Orneodes zonodactyla var. *eumorphodactyla* Caradja, 1920: 88. Type locality: Radde, Amur Region, Russia.

Alucita eumorphodactyla: Gielis 2003: 110; Ustjuzhanin and Kovtunovich 2008: 150.

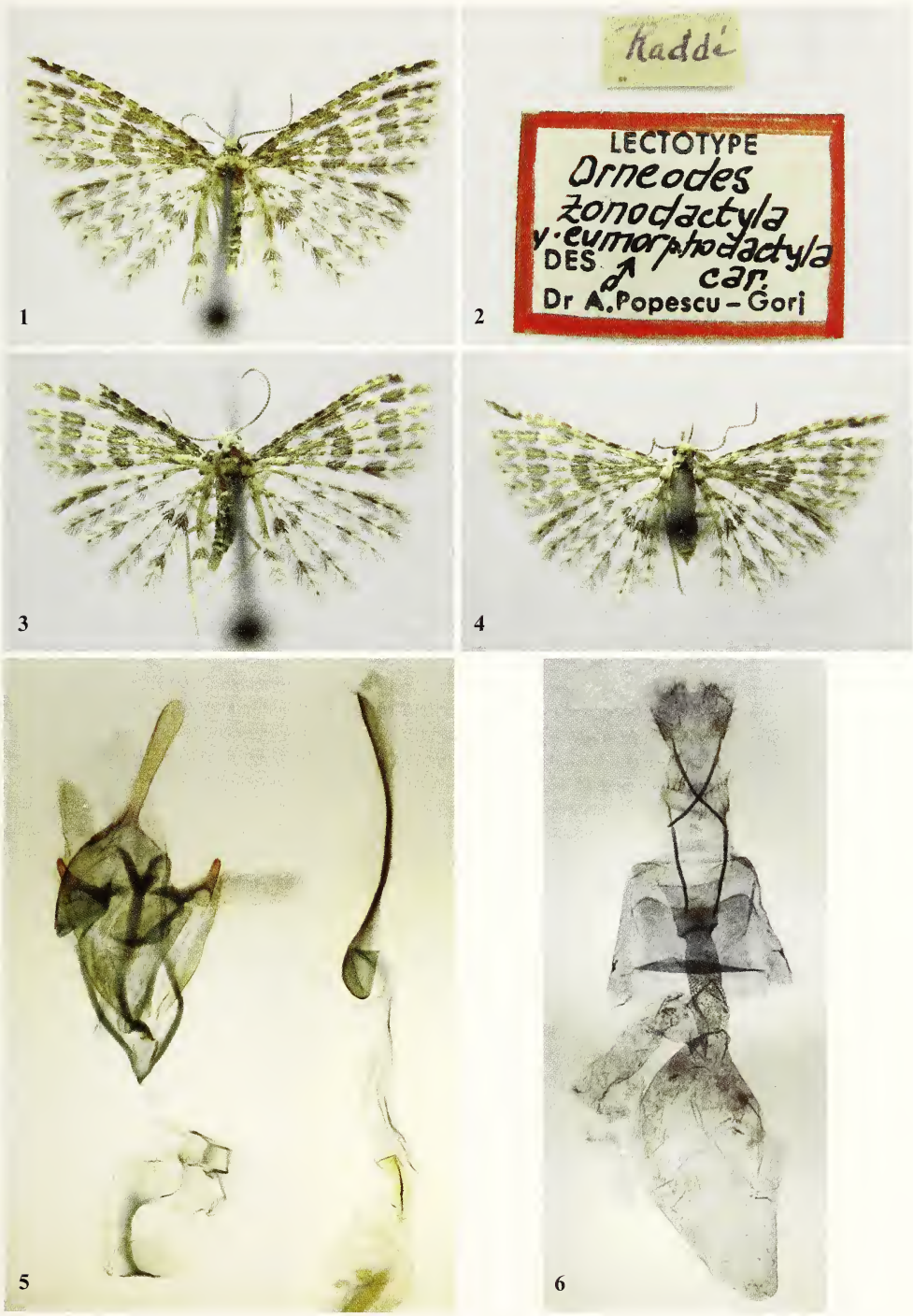
Alucita sakhalinica Zagulajev, 1995: 111. Type locality: South Sakhalin, Russia. Syn. nov. *Pterotopteryx koreana* Byun, 2006: 42. Type locality: Unduryeong, Mt. Gyebang, Province Gangweon-do, Korea. Syn. nov.

Material. Russia. South Sakhalin: Pik-Chekhova, h – 500 m, 2.06.1988, 1♂ (holotype), leg. M. Nesterov (ZISP); same data as holotype, but 2.06.1988, 4♂,2♀, 12.06.1988, 1♂, 1♀, 21.06.1988, 1 ♂ (paratypes), leg. M. Nesterov (ZISP); Yuzhno-Sakhalinsk, 30.vi.–3.vii.1983, 7 ex., leg. S. Sinev (ZISP); Sinegorsk, 3.vii.1991, 1♀, leg. A. Kupriyanov (CUK); Novoalexandrovka village, 30.vi.1991, 1♂, leg. A. Kupriyanov (CUK); Urozhaynoe village, 22–23.vi.1989, 3♂, leg. V. Dubatolov (ISEA). Kurile Islands: Kunashir Isl., Sernovodsk, 12.vii.1967, 2 ex., leg. Zabello (ZISP); Shikotan Isl., 20.vi.1973, 1♂, 1♀, leg. I. Kerzhner (ZISP). Khabarovskii Krai: 20 km W of Nikolayevsk-on-Amur, Archangel'skoe village, 15–18.vii.2009, 6 ex., leg. V. Dubatolov (ISEA, CUK); Bolshekhekhtsirskii Nature Reserve, Bychikha village, 26.v.2006, 1 ♂, leg. V. Dubatolov (CUK); Pivan' village, 31.v. 2008, 1♂, leg. A. Syatchina (CUK). Amur Region: Bastak Nature Reserve, 7–15.vi. 2004, 1♂, 1♀, leg. A. Streltzov (CUK); Blagoveshchensk, 1.vi. 2012, 1♂, leg. A. Streltzov (CUK). Primorsky Krai: Barabash village, 16-19.viii, 2008, 1 ♂, leg. A. Streltzov, P. Osipov, E. Malikova (CUK); 20 km E of Ussuriisk, Gornotajozhnoe village, 1.vi.1994, 1 ♂, leg. V. Dubatolov (ISEA).

Distribution. Russian Far East: Sakhalin, southern Kurile Islands, Khabarovskii Krai, Amur Region, Primorsky Krai. Korean Peninsula.

Life history. Biology unknown. Flight period: V–VII. Probably develops in two generations.

Remarks. The type series of *Orneodes zonodactyla* var. *eumorphodactyla* Caradja, 1920 consists of six specimens held in MGAB. Dr. Mihai Stănescu, Lepidoptera collection manager in this museum, kindly sent us the abdomens of two paralectotypes for genitalia dissection. Our study of the male genitalia as well as external morphology revealed a number of diagnostic characters for the genus *Pterotopteryx* Hannemann, 1959 (third segment of labial palpus short, less than 1/3 as long as second segment; all five forewing R veins developed; valva with broad base; uncus undivided apically; gnathos acute apically; phallus nearly straight with spiniform cornuti in vesica) which provide ample



Figures 1–6. *Pterotopteryx eumorphodactyla* (Caradja). **1.** Lectotype, male. **2.** Lectotype label. **3.** Paralectotype, male. **4.** Paralectotype, female. **5.** Paralectotype, male genitalia. **6.** Paralectotype, female genitalia. (Photo: M. Stănescu,1–4 and V. Kovtunovich, 5, 6)

reason for treating this taxon as a valid species within *Pterotopteryx*. In addition, all characters studied revealed the obvious conspecificity of *Pterotopteryx eumorphodactyla* with the recently described *Alucita sakhalinica* Zagulajev, 1995 (Zagulajev 1995: 111–115, figs 4–5) and *Pterotopteryx koreana* Byun, 2006 (Byun 2006: 42, figs 6–9). In particular, the following character states are diagnostic. The wings are yellowish ashy, the middle and outer bands are well defined, and there are several contrasting spots on the costal margin of the forewing, near the base. In the male genitalia, the uncus is laterally narrow and its apex is lanceolate in frontal aspect, the valvae are wide and sclerotized near the base, narrow and membranous to the apex, and the phallus is slightly curved and with well-developed cornuti. In the female genitalia, the antrum is cup-shaped, the bursa copulatrix is oval with a rounded signum, and the ductus is covered with small spines.

Alucita ussurica Ustjuzhanin, 1999

Alucita ussurica Ustjuzhanin, 1999: 2. Type locality: Gornotajozhnoe, Primorsky Krai, Russia.

Material. Russia. Primorsky Krai: 20 km E of Ussuriisk, Gornotajozhnoe village, 11.vi. 1983, 1♂ (holotype), leg. S. Sinev (ZISP); same locality, 12.vii.1990, 1♂, 11.vi.1983, 2♂ (paratypes), leg. S. Sinev (ZISP); 8.vii.1990, 1♀ (paratype), leg. P. Ustjuzhanin (CUK); Kamenushka village, 12.vii.1990, 1♂ (paratype), leg. P. Ustjuzhanin, S. Zakharov (ISEA); Kedrovaya Pad' Nature Reserve, 14 -15.vii.1984, 1♂, 2 ♀ (paratype), leg. A. Lvovsky (ZISP); same locality, 25.vii.1998, 2♂, 1♀ (paratype), leg. S. Sinev (ZISP); Ananievka River headwaters, 7.vii.1982, 1♂ (paratype), leg. S. Sinev (ZISP); Khasan district, Zanadvorovka village, 4-19.vii.2004, 2♂, leg. A. Streltzov, P. Osipov, D. Filatov (CUK).

Distribution. Russian Far East: south of Primorsky Krai.

Life history. Biology unknown. Flight period: VI–VII. Probably develops in two generations.

Remarks. This species, previously known only from its type locality, is actually more widely distributed in the region. In conclusion, only two species of many-plumed moths are known in the south of the Russian Far East: *Pterotopteryx eumorphodactyla* and *Alucita ussurica*.

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Cataclysme subtilisparsata Wehrli, 1932 (Lepidoptera, Geometridae, Larentiinae) recognized as bona species – an integrative approach

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Abstract. Based on morphological and molecular analyses of "*Cataclysme riguata* Hb. var. *subtilisparsata* Wehrli, 1932" and *C. riguata* (Hübner, 1813) the former is raised to species rank. *C. subtilisparsata* is re-described here and compared with *C. riguata*. Molecular data derived from DNA barcoding are discussed. We illustrate male and female genitalia of both species and present data on life history and morphology of the early stages of *C. subtilisparsata*.

Introduction

Cataclysme Hübner, [1825] is a small West-Palaearctic genus of moths belonging to the tribe *Cataclysmini* Herbulot, 1961 (Larentiinae, Geometridae). Viidalepp (2011) and Hausmann and Viidalepp (2012) listed the tribal diagnostic characters. In both checklists of Scoble (1999) and Scoble and Hausmann (2007) seven species are listed for this genus. Recently Viidalepp (2009) and Choi and Stüning (2011) revised the Eastern Palaearctic genus *Paraplaneta* Warren, 1895, recognizing eight species for *Paraplaneta* and leaving five species in the genus *Cataclysme*. All members of *Cataclysme* are of medium size, their coloration varying from light brownish to dark grey. On the wing upper side all transverse lines are well developed, sinuate or dentate, distinct, and whitish. The coloration of the head, frons and vertex correspond rather well to that of the wings. The palpi are short, reduced in size, the proboscis is well developed and chaetosemata are present as two elongate patches. The abdomen and anal tuft are concolorous with wings. Male antennae are broadly flattened laterally, with very short ciliae, which are bipectinate in the closely related genus *Paraplaneta*. The forewing R5 is stalked with M1, and the areole is present. In male genitalia the uncus is flat, bifid with projections distally rounded and basally fused (Viidalepp 2009). The male genitalia have a "pseudojuxta" (see streak in Fig. 7a), an autapomorphy of *Cataclysme* and *Paraplaneta* within the tribe Cataclysmini (Choi and Stüning 2011). The phallus is long, with termino-lateral spinulose crests ('dorsal-external carina' in Viidalepp

2011) and forked vesica with lines of cornuti (the latter are not present in *Paraplaneta*). The female genitalia (except for corpus bursae) are strongly sclerotized. The ductus bursae is furrowed, the ostium cleft and fused to sternite A7 (Viidalepp 2011). The species are bivoltine or facultative bivoltine and inhabit Mediterranean macchia such as all kinds of steppe biotopes from forest to open xero-montane steppes. So far as is known the larvae are oligophagous feeding on species of *Galium* and *Asperula* (Rubiaceae).

Cataclysme subtilisparsata Wehrli, 1932 was described as a variation of *Cataclysme riguata* (Hübner 1813) based on two specimens (1 ♂, 1 ♀; collected by Pfeiffer near Maraş in June 1929). Prout (1938) regarded the first as a subspecies of the latter, while Scoble (1999) did not mention that taxon at all. The status of this taxon remained unclear until now, due to the lack of sufficient material. Specimens recently collected in south-east Turkey, however, are allowing an integrative taxonomic revision of this taxon. Breeding experiments were undertaken to obtain more information about larval morphology and bionomic data. Results of morphological (genitalia) and DNA-barcode analyses show *C. subtilisparsata* to be a distinct species (the sixth of the genus) and not a form or subspecies of *C. riguata*.

Materials and methods

Morphological studies

Specimens were photographed before performing a standard method of dissection (Robinson 1976). Genitalia slides were photographed using Zeiss digital stereomicroscope (ZEISS-SteREO: Discovery.V20). Specimens were identified based on comparison with the syntype and the original description (Wehrli 1932).

More than 300 specimens of *Cataclysme riguata* were examined for comparison from following regions: Turkey (west, north, east), Iran (north, west, central), Caucasus (Georgia, Russia, Armenia), Europe (e.g. Germany, Austria, Hungary, France, Spain, Italy, Slovenia, Croatia, Macedonia, Greece, Bulgaria, Ukraine). Furthermore specimens of the following species were used for morphological examination and DNA barcoding (see Appendix): *Cataclysme uniformata* (Bellier, 1862); *C. dissimilata* (Rambur, 1833); *C. festivata* Staudinger, 1892; *Paraplaneta sternecki* (Prout, 1938).

Specimens from the following collections have been examined:

ZFMK Zoological Research Museum Alexander Koenig, Bonn
ZSM Bavarian State Collection of Zoology, Munich
PCDS Private collection Dirk Stadie, Lutherstadt Eisleben

DNA amplification and sequencing

PCR amplification and sequencing of 658 bp of COI mtDNA of the three freshly collected specimens of *C. subtilisparsata* was successful using standard protocols (Ivanova et al. 2006) at the Canadian Centre for DNA Barcoding (CCDB; Guelph), in the framework of the Lepidoptera Campaign of the international Barcode of Life program iBOL (see: www.lepbarcoding.org).

Data analysis

Sequences were aligned using BOLD platform (www.boldsystems.org). For construction of the neighbour-joining tree (using K2P model: Kimura 1980) and for calculation of the genetic distances we used MEGA5 (Tamura et al. 2011). For analysis the DNA barcodes of 17 individuals (of five *Cataclysme* and one *Paraplaneta* species) with fragment length >500bp were used. All sequences can be accessed in public projects on the barcode of Life Data Systems (BOLD; data-set DS-Cataclys, www.boldsystems.org; cf. Ratnasingham and Hebert 2007), such as in GenBank (for list of analyzed specimens and their GenBank accession numbers see Appendix).

Results and discussion

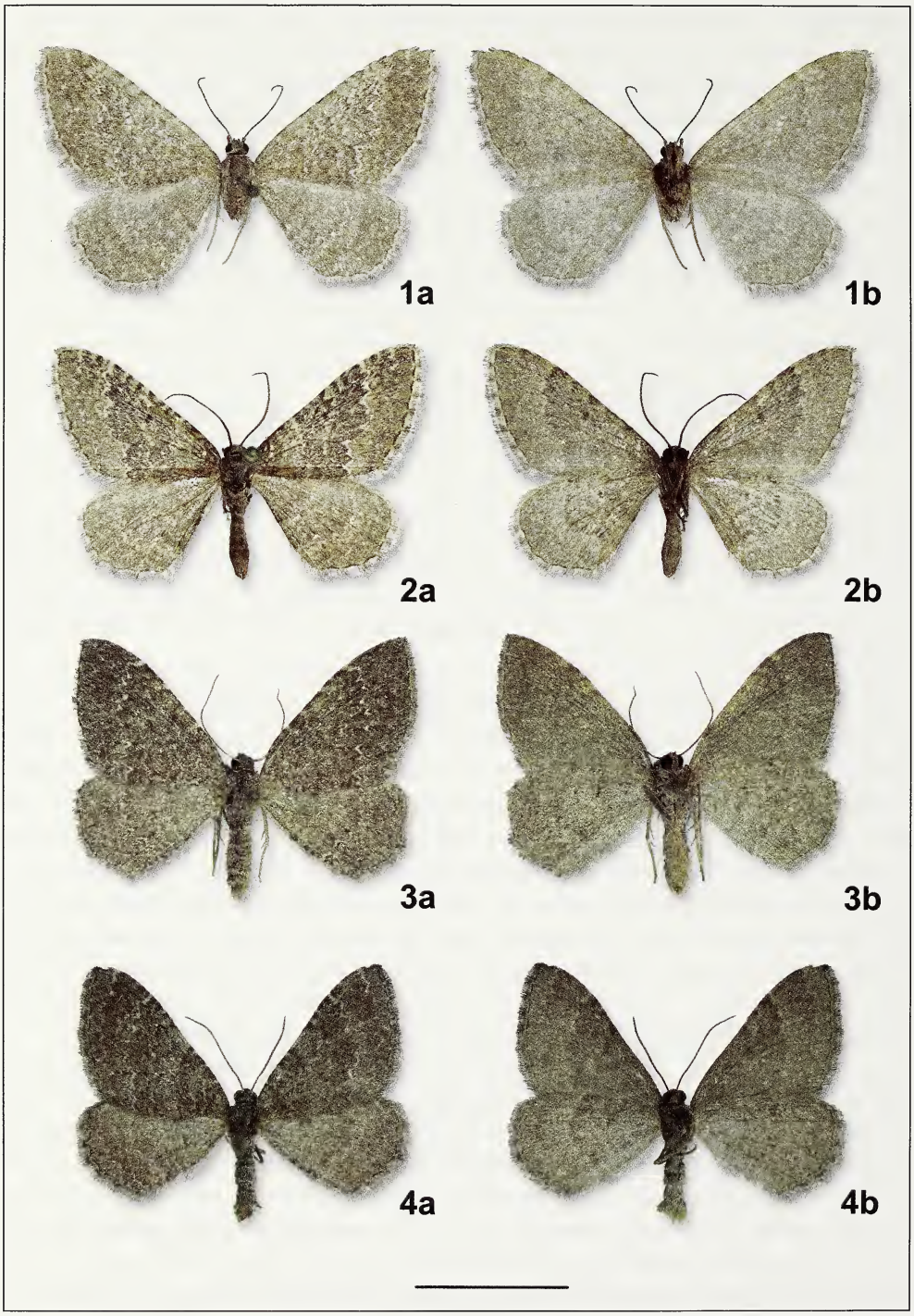
Cataclysme subtilisparsata Wehrli, 1932, bona sp.

Figs 1, 2, 5, 6, 10 and 11

Cataclysme riguata Hb. var. *subtilisparsata* Wehrli, 1932: Mitt. Münchn. Ent. Ges. 20: 7. Locus typicus: southern Turkey, Achyr Dagh near Maras: Bertiz Jaila. Syntypes 1 ♂, 1 ♀ (female traced in ZFMK; male not traced). The original description of *subtilisparsata* does not include any indication for an infrasubspecific understanding but compares features in correlation to geographic distribution areas. Although in Wehrli's paper several other taxa are introduced as "ssp." this fact alone cannot be interpreted generally and "without doubt" (cf. §45.6.1 Code ICZN) as an infrasubspecific meaning of "var." in Wehrli (1932). Therefore the name is available according to §45.6.1 Code ICZN.

Material examined. Lectotype (hereby designated in order to stabilize nomenclature) ♀, "Syr. sept. [Turkey], Marasch, Achyr Dagh sept. Bertiz Jaila, 1800m, 09.-13.vi. [19]29, E. Pfeiffer leg.", "*Cataclysme riguata* Hb. var. *subtilisparsata* Wrli.", "Type", "Prep. Nr. G 81, ♀, G. Ebert", "BC ZFMK Lep 00781"; 1 ♀, S-Ost [S-East] Turkey, Hakkari Uludere, Tanin Tanin, 2200 m, 05.vi.1985, leg. P. Kuhna; 1 ♀, Ost [East] Turkey, Van, 2600 m, Güzeldere Paß, 06.vii.1979, leg. P.Kuhna, g. prep. 1491/2011 H. Rajaei; 1 ♂, same data, 18.vi.1985; in ZFMK. 5 ♂, 5 ♀, Turkey centr. Provinz Adiyaman, Nemrut Dag, 38°02'07" N / 38°45'48" E, 1700-2000 m ü.NN, 23.-25.v.2009, LF, leg. Fiebig & Rothe, g. preps: ♂ 1805, ♀ 1806/2012 H. Rajaei; in coll. Stadie. 1 ♂, "Syria s., [Turkey], Taurus, Marasch, Einh.Slg. [local collectors] leg., 20.vi.34: in ZSM. 1 ♂, same data, viii.29; 2 ♂, same data, x.29, one with g. prep. ZSM G 8945; 1 ♂, O-Turkey, Hakkari, östl. Bagisli, 1600 m, 09.vii.1979, leg. Gross, in coll. EMEM/ZSM. 1 ♀, [northern] Iran, Pr. Mazandaran, Al Borz Mts. [Resteh-Ye-Elborz], 2998 m, Mazandaran Pass, 36.231° N / 51.438° E, leg. and coll. G. Petrany, DNA Barcode BC PG Lep 0100.

Redescription. Wingspan 25–29 mm, forewing length 13.2–15.0 mm; n=11. Apex pointed. Termen slightly rounded. Ground colour of forewing light ochre-brown to light grey-brown; basal and medial area darkened in half of all individuals, the others rather uniform; transverse lines well developed, distinct and dentate; postmedial line bordered distally with white scales; subterminal line narrow, whitish, more or less complete; terminal line fine dark brown, streak-like, interrupted at the veins; costa often suffused with whitish scales. Cell spots round, always present but often weak and hardly visible. Fringes slightly lighter than ground colour, chequered. Hindwing colour slightly lighter than forewing. Transverse lines usually indistinct except the postmedial and terminal lines. Cell spots usually absent. If present then very weak, developed as an elongate streak. Underside of both wings lighter than upper side, suffused with light ochre-brown scales. Trans-



Figures 1–4. Wing pattern. **1** and **2**, *Cataclysme subtilisparsata*: **1.** Lectotype, ♀, Achyr Dagh (Marasch, Turkey); **2.** ♂ from Nemrut Dag (Adiyaman prov. Turkey). **3** and **4**, *Cataclysme riguata*: **3.** ♀ from N Aksar (NE Turkey); **4.** ♂ from West Ügrüp (Turkey); a. upperside; b. underside. Scale bar: 1 cm.

verse lines absent or strongly reduced except the postmedial and terminal lines. Cell spots on both wings weak, but always present. Head and frons unicolorously ochre-brown. Palpi reduced in size. Antennae of male slightly dentate in lateral view, those of female filiform. Tibia of forelegs without spurs, of mid-legs with one pair, of hindlegs with two pairs of spurs. Chaetosemata present.

Male genitalia. Uncus flat, bifid, projections distally rounded. Valva broadly sclerotized at costa, with a rounded lobe and a deep, sub-apical incision. Apical projection thin, with small rounded tip. Juxta narrow and largely reduced, situated between the oval basal parts of the valvae and behind the pseudojuxta (only partly visible in Figs 5a, 7a), saccus well developed, broad. Phallus straight, long and slender with termino-lateral spinulose crests; vesica biforked with numerous cornuti (Figs 5a, b).

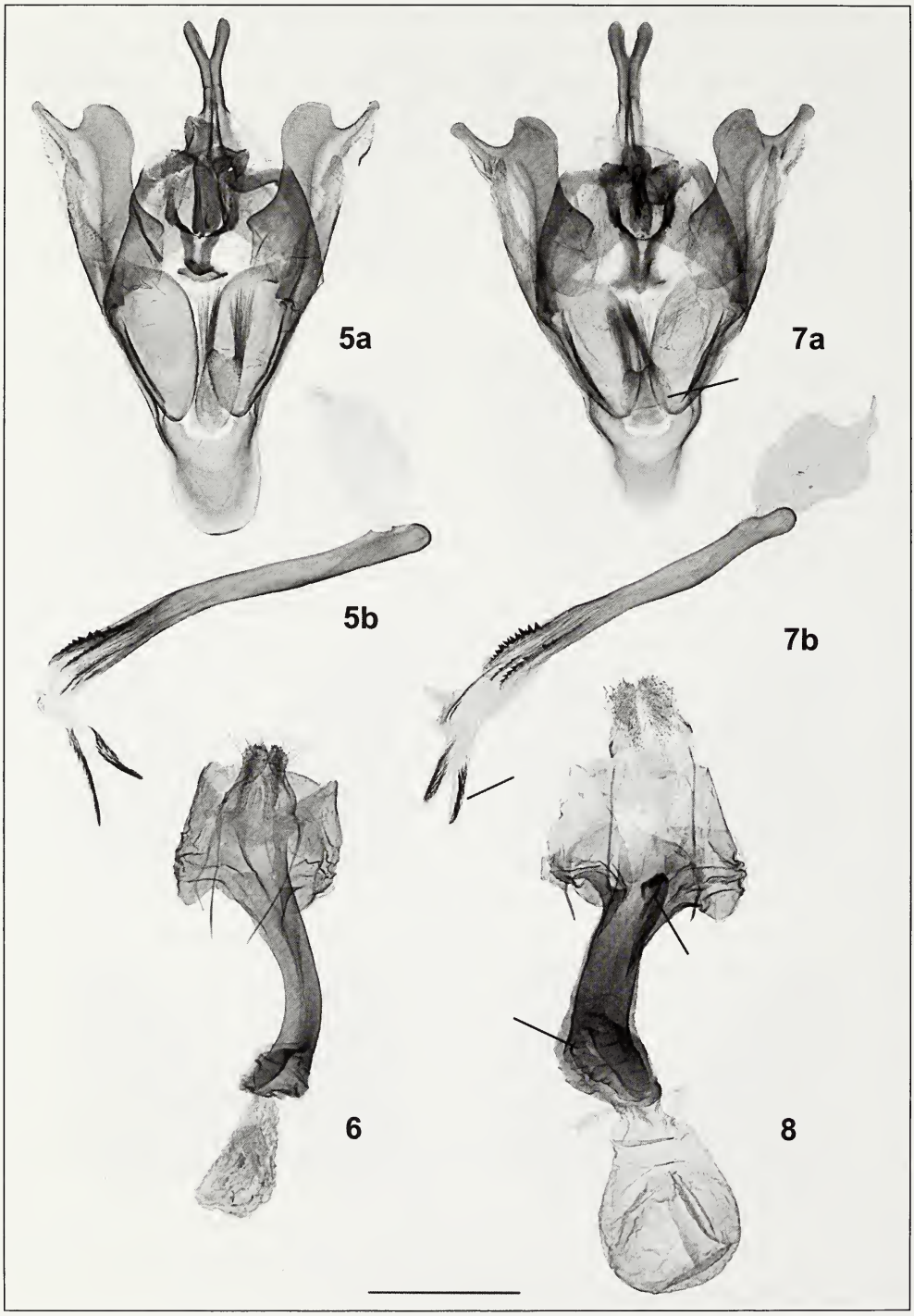
Female genitalia. Ductus bursae furrowed, slightly curved, near ostium remarkably widened, more sclerotized. Corpus bursae membranous (Fig. 6).

Diagnosis. *C. subtilisparsata* differs from the closely related *C. riguata* by its slightly larger size. Wingspan in the latter 20–25 mm (n>100) in the former 23–27 mm (n=16), in one specimen from Hakkari, however, only 21 mm. The ground colour is notably lighter, on average. Specimens with darkened basal and medium field never occur in *C. riguata*. Despite a wide range of variation the transverse lines, especially basal and antemedial lines, are often more zigzagging and thus more reminiscent of *C. uniformata* (Bellier 1862) than of *C. riguata*. Furthermore, the forewing cell spots are usually absent in the latter. In male genitalia, pseudojuxta of *C. riguata* (Fig. 7a) round, in *C. subtilisparsata* elongate sub-rectangular (Fig. 5a). In female genitalia, ductus bursae of *C. riguata* (Fig. 8) larger, more robust and more strongly sclerotised than in *C. subtilisparsata* (Fig. 6)

DNA barcoding. Genetic similarity and interspecific distances are shown in the neighbour-joining tree (Fig. 9). Exact distance values are listed in Table 1. Based on these data *Calaclysme subtilisparsata* is more than 7% divergent from all other examined *Calaclysme* and *Paraplaneta* species, confirming our hypothesis of species rank for *C. subtilisparsata*. However, sequencing of more specimens from northern Iran and all regions of Turkey is highly recommended. Furthermore, the identity of the taxon *festivata* needs to be investigated (cf. Fig. 9) and its lectotype designated. We consider here the populations from Kyrgyzstan and Uzbekistan as belonging to this taxon. The interpretation of Scoble (1999) (mentioning 'Amur' as locus typicus) is erroneous; Staudinger (1892) clearly states that "the Central Asian populations from Alai, Alexander Mountains, Osch, Usgent, Namangan and Prov. Samarkand" should bear this name. Preliminary data furthermore suggest that there is another taxon forming a separate genetic cluster, so far recorded from Georgia, eastern Turkey and Altai mountains. We do not exclude the possibility that this cluster refers to "*Cataclysme riguata elbursica* Wagner, 1937". *Cataclysme shirniensis* Ebert, 1965 (described from N. Afghanistan) is not included in the present study due to the lack of material.

Geographic distribution. So far *Cataclysme subtilisparsata* is known only from the high mountain chains of south-east Turkey from Ceyhan Valley in the west to the mountain ridge south of Van in the east and Mazandaran in north Iran (see Fig 9).

Bionomics. Similar to other *Cataclysme* species, *C. subtilisparsata* is a bivoltine species. The flight period of the first generation lasts from mid-May to the first third of June. The second brood occurs in July (result of *in-vitro* breeding experiments by first author and *in-vivo* by Ralf Fiebig in Nemrut-mountain, pers. comm.). The species inhabits steep, more humid east- and north-facing



Figures 5–8. Male and female genitalia. **5** and **6**, *Cataclysme subtilisparsata*: **5.** male (gen prep. 1805/2012 H.R.); **6.** Lectotype (gen prep. G 81); **7** and **8**, *Cataclysme riguata*: **7.** male (gen prep. 1807/2012 H.R.), **8.** female (gen prep. 1492/2011 H.R.); a. male genitalia aparat; b. phallus. Abbreviations. pj, pseudojuxta; tl.c, termino-lateral crests; v, vesica. Scale bar: 1 mm.

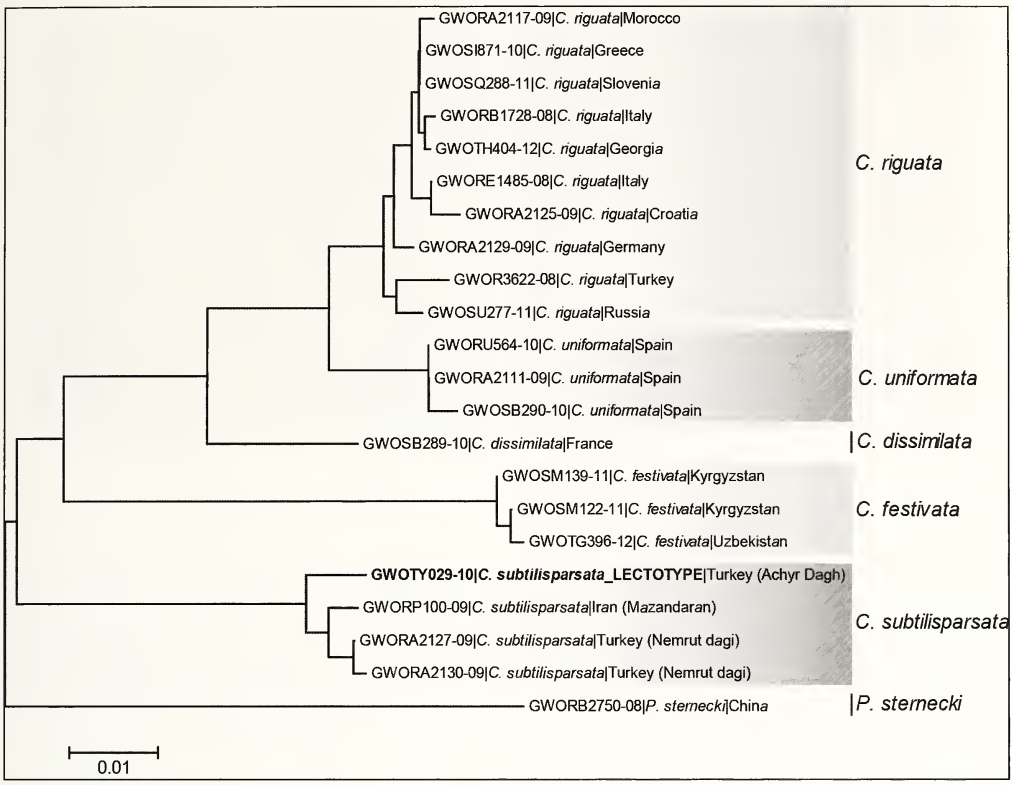


Figure 9. Un-rooted neighbour-joining tree based on individuals belonging to six species of the genera *Calaclysme* and *Paraplaneta* (calculated using the Kimura 2-parameter model with MEGA 5 (Tamura et al. 2011)).

Table 1. Interspecific distances between six species of the genera *Cataclysme* and *Paraplaneta* (in %) (based on COI 5' mt-DNA gene fragments, calculated using the Kimura 2-parameter model with MEGA 6 (Tamura et al. 2011)). The distances between *C. subtilisparsata* and other taxa have shown in bold.

	1	2	3	4	5
1. *C. uniformata*					
2. *C. festivata*	9.3				
3. *C. subtilisparsata*	**8.7**	**9.8**			
4. *C. riguata*	2.4	9.1	**8.6**		
5. *P. sternecki*	10.5	11.3	**9.5**	10.7	
6. *C. dissimilata*	4.2	8.6	**7.2**	4.2	9.7

escarpments and outcrops from 1500–2100 m above sea level. The slopes are mainly covered with stands of thorny cushion plants dominated by xero-montane *Acantholimon* (Plumbaginaceae) and *Astragalus* (Fabaceae) mixed with herbaceous vegetation. The host plant is probably a low growing, white-flowering *Asperula* sp. (Rubiaceae). In captivity the caterpillars accepted other Rubiaceae like *Galium mollugo* L. and *G. verum* L. The development lasts three weeks under laboratory conditions. The species shares its habitat with Ennominae species: *Charissa pfeifferi* (Wehrli, 1951), *Charissa mutilata* (Staudinger, 1879) and *Gnophos libanotica* (Wehrli, 1931).

Figures 10, 11. *Cataclysme subtilisparsata* in Turkey, Dogu Anadolu, Province Malatya, north of Nemrut Dag. **10.** Imago (female), **11.** larva.

Larva. Full-grown larva (L5) moderately slender, length 3 cm. Ground colour dorsally light green. Head beige. Epistigmatal line fine, whitish. Stigmatal line broad, ivory coloured, with a yellow tinge, indistinct. Stigmata bright yellow, bordered by a fine black margin. The whole body is covered scarcely with fine blackish setae, with small blackish patches at their bases. Ventrum uniform whitish-green (Fig. 11).

Acknowledgements

We are grateful to Ralf Fiebig (Roßleben, Germany) for loan of his material and additional ecological information on this species. Our special thanks go to Paul Hebert (CCDB, University of Guelph, Canada) and his team for kindly and professionally performing sequencing of the material. Furthermore we thank Jaan Viidalepp (Tartu, Estonia) and Bernd Müller (Berlin, Germany) for competent help and additional information on the tribe *Cataclysmini*. We are grateful to Dieter Stüning (Bonn, Germany) for the possibility to work in the ZFMK (Bonn) and for help and advice in preparing this paper. We thank our friend Lutz Lehmann (1963–2011), who was the first to identify the recently collected material as *C. subtilisparsata*.

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Appendix

List of sequenced specimens, with identification, Sampling sites collecting data, Accession numbers, and process ID in BOLD database. Data taken from BOLD and generated by Axel Hausmann [(1)]; Norbert Pöll [(2)]; Petrányi Gergely [(3)], Dieter Stüning [(4)].

Taxon identification	Sampling site	Genbank Accession Nr.	Process ID (in BOLD database)
C. riguata [(1)]	Italy, Calabria, Prov. Cosenza, Strada per Aieta, 39.924° N, 15.793° E, 340 m, 1.IX.1991, leg. A. Hausmann, coll. ZSM	KJ637336	GWORB1728-08
C. riguata [(1)]	Slovenia, Kras-Prešnica, 45.5667 N 13.9333E, 01.V.2005, leg. M. Petru, coll. Prohaska.	KJ637333	GWOSQ288-11
C. riguata [(1)]	Greece, West-Macedonia, Vogatsikon (suedl. Kastoria), 29-May-2006, 40.4° N, 21.2° E, leg. L. Weigert, coll. ZSM, Neotype!	KJ637337	GWOSI871-10
C. riguata [(1)]	Morocco, Province Souss-Massa-Draa, Agadir env.[ironments], 10km N[orth] Agadir,30.505N 9.6628W, 15.IV.2002, leg. K. Cerny & M. Hluchy, coll. ZSM.	GU655488	GWORA2117-09
C. riguata [(1)]	Germany, Thuringia, S[üdlicher] Kyffhäuser, Ochsenburg, 08.V.2006, leg. et. coll. Dirk Stadie.	GU655489	GWORA2129-09
C. riguata [(1)]	Italy, Calabria, Prov. Cosenza, Strada per Aieta, 39,9239° N, 15,7925°E, 5000 m, 28.VIII.1997, leg. A. Hausmann, coll. ZSM	KJ637340	GWORE1485-08
C. riguata [(1)]	Croatia, Primorje-Gorski Kotar, Krk Island, Bašćanska Draga, 12.VI.2000, leg. et. coll. Dirk Stadie.	GU655487	GWORA2125-09
C. riguata [(1)]	Turkey, Dogu Anadolu, Erzincan, 20 km S. Erzincan, 39,73°N, 39,5°E, 18-Jun-1995, leg. M. Geck, coll. ZSM	KJ637338	GWOR3622-08
C. riguata [(1)]	Russia, Tuva, near Shagonar, Khairakan Mt., 565 m, 51,8953°N, 93,5375°E, 03-Jun-2010, leg. R. Yakovlev, coll. ZSM.	KJ637335	GWOSU277-11
C. dissimilata [(1)]	France.Corsica, Val d'Ese, 6km E Bastelica, 1600 m, 17.VII.2004, 41.997°N, 9.1204° E, leg. et coll. P. Skou	HQ957809	GWOSB289-10
C. uniformata [(1)]	Spain, Castilla-La Mancha, Guadalajara, 4km E Embid, 1075 m, 08.08.2007, leg. P. Skou	HQ957810	GWOSB290-10
C. uniformata [(1)]	Spain, Aragon, Torres de Albarracin, 40.4058N 1.49444W, 2.V.2003, 1250m, leg. K. Cerny, coll. ZSM	GU655485	GWORA2111-09
C. uniformata [(2)]	Spain, Aragon, Teruel, Sierra Albarracin, Moscardon, 1440 m, 22-May-2006, 40,32° N, 1,53°W, leg. R. Leimlehner, coll. N. Pöll	HM910684	GWORU564-10
C. riguata [(4)]	Georgia, Kachetia, Tusheti, David Gazeta, 4.VII.2010, 41.2724°N 45.2209°E, leg. M. Franzen, coll. ZSM	KJ637334	GWOTH404-12
C. subtilisparsata [(3)]	Iran, Mazandaran, Resteh-Ye-Elborz, Mazandaran Pass, 2988 m, 22-Jun-2005, 36,231°N, 51,438°E, leg. et coll. G. Petrany	HM393814	GWORP100-09
C. subtilisparsata [(1)]	Turkey, Dogu Anadolu, Province Malatya, Nemrut dagi northside, 38.0386N 38.7669E, 23.V.2009, 1500 m, leg. D. Stadie & H. Loebel, coll. Dirk Stadie.	GU655490	GWORA2127-09
C. subtilisparsata [(1)]	Turkey, Dogu Anadolu, Province Malatya, Nemrut dagi northside, 38.0386N 38.7669E, 23.V.2009, 1500 m, leg. D. Stadie & H. Loebel, coll. Dirk Stadie.	GU655492	GWORA2130-09
C. subtilisparsata [(1)]	Syria[Turkey], Achyr Dagh, Bertiz Jaila, 13.VII.1929, 1800 m, leg. E. Pfeiffer, Lectotype	KJ637341	GWOTY029
C. festivata [(2)]	Kyrgyzstan, Prov. Osh, Distr. Nookat, Kitschik-Alai, Abschyr-Say, 1820m, 20-Jun-2010, 40,14°N, 72,36°E, leg. et coll. N. Pöll	JN274367	GWOSM139-11
C. festivata [(2)]	Kyrgyzstan, Prov. Osh, Distr. Kara-Suu, Alai-Mountains, River Ak-Buura, Tarylga vic., 1535 m, 4-Jun-2010, 40,17°N, 72,97°E, leg. et coll. N. Pöll	JN274358	GWOSM122-11
C. festivata [(1)]	Uzbekistan, Tashkent, Parkent, reg. Surenata Mts., 900 m, 10-May-1995, 41,283°N, 69,7°E, leg. S. Murzin, coll. ZSM	KJ637342	GWOTG396-12
P. sternecki [(1)]	China, Beijing Shi, Yanqing, Dayushu, 520 m, 13-Jun-2007, 40,38°N, 115,95°E, leg. C. Wang, coll. ZSM.	KJ637339	GWORB2750-08

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Application of two molecular approaches (use of sex attractants and DNA barcoding) allowed to rediscover *Zygaenoprocris eberti* (Alberti, 1968) (Lepidoptera, Zygaenidae, Procridinae), hitherto known only from the female holotype

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http://zoobank.org/751519B1-E464-42BE-AB62-84D794231186

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Abstract. The hitherto unknown males of *Zygaenoprocris* (*Zygaenoprocris*) *eberti* (Alberti, 1968) were attracted by sex pheromones in Afghanistan. Conspecificity with the female holotype was confirmed by using DNA barcoding. A description of the male and data on the habitat of this species are provided. A key to the subgenera of the genus *Zygaenoprocris* Hampson, 1900, and the species of the subgenus *Zygaenoprocris* Hampson, 1900, is given.

Introduction

The subfamily Procridinae (Lepidoptera, Zygaenidae) includes some genera with externally very similar species, e.g. *Fuscartona* Efetov & Tarmann, 2012 (Efetov 1997a), *Chrysartona* Swinhoe, 1892 (Efetov 2006), *Illiberis* Walker, 1854 (Efetov 1997b; Efetov et al. 2004), *Hedina* Alberti, 1954 (Efetov 1997b; Efetov 2010; Efetov and Tarmann 2012), *Goe* Hampson, 1893 (Efetov 1998), *Adscita* Retzius, 1753 (Efetov 2001b; Efetov and Tarmann 2012), *Jordanita* Verity, 1946 (Efetov 2001b; Efetov and Tarmann 2012) etc. Species of the mentioned genera can often be identified only by examination of genitalic structures (Efetov and Tarmann 1999), chaetotaxy of the first instar larvae (Efetov et al. 2006; Efetov and Hayashi 2008), karyotypes (Efetov 2004; Efetov et al. 2004) or DNA analysis. Some species are known only from the type specimens and sometimes only one sex is known. The identification of material of the other sex needs to be verified by molecular methods. One such genus is *Zygaenoprocris* Hampson, 1900 (Efetov and Tarmann 1994; Efetov 1996; 2001a), which is currently represented by 13 species (Efetov and Tarmann 2012).

Hitherto *Zygaenoprocris eberti* (Alberti, 1968) was known only from the holotype, a female labelled 'Z.-Afghanistan, Koh-i-Baba, S-Seite Shahtu-Pass, 3000 m, 17.–19.7.1966, G. EBERT leg.' and collected on the south side of the pass known as Kotal-e Shahtu that crosses the Koh-i

Baba main chain between Panjao and Yakolang (Figs 4, 10). The discovery of the males of this species became possible by the use of two molecular methods: attraction by sex pheromones followed by confirmation of conspecificity of the collected males with the female holotype by DNA barcoding.

Two esters of fatty acids, 2-butyl (7*Z*)-dodecenoate and 2-butyl (9*Z*)-tetradecenoate, were found in the female pheromone glands of *Illiberis* (*Primilliberis*) *rotundata* Jordan, 1907 and both (*R*)- and (*S*)-enantiomers of each compound were synthesized (Subchev et al. 2010). These compounds and their mixtures were screened in the field and proved to be sex attractants for different species of the genera *Illiberis* Walker, 1854 (Subchev et al. 2012; 2013), *Zygaenoprocris* Hampson, 1900 (Efetov et al. 2011), *Adscita* Retzius, 1783, and *Jordanita* Verity, 1946 (Efetov et al. 2010; Subchev et al. 2010).

Methods

During an expedition to Afghanistan in 2011, Axel Hofmann, using baits containing the above-mentioned female sex attractants and their mixtures, collected a series of males of *Zygaenoprocris eberti* in the vicinity of the lakes of Band-i Amir (*ca.* 40 km north-east of the type-locality) in the central Koh-i Baba in Hazarajat in Afghanistan (Efetov et al. 2012). Male specimens were attracted to (2*R*)-butyl (7*Z*)-dodecenoate and the mixture of (2*R*)-butyl (7*Z*)-dodecenoate and (2*R*)-butyl (9*Z*)-tetradecenoate (Fig. 2). The pin-label data are as follows: "Afghanistan, Prov. Bamiyan, Band-i Amir, Jarkushan N, Canyon, 3130–3280 m, 5.VII. 2011, [15/11], leg. A. HOFMANN". At this locality *Z. eberti* was syntopic with *Z. chalcochlora* Hampson, 1900 (Figs 3, 10). Amongst the 38 collected males 37 were *Z. eberti* and only one male was *Z. chalcochlora*. In other localities in Afghanistan which were visited during the same collecting tour by A. Hofmann in 2011, only *Z. chalcochlora* could be found. Males of the latter species were seen resting (Fig. 9) and actively flying but a clear preference to any of the presented sex attractants could not be verified.

DNA barcodes were obtained by sampling legs from dry specimens. Legs were prepared in the Department of Biological Chemistry of the Crimean State Medical University (Simferopol). All specimens were identified by K. A. Efetov & G. M. Tarmann. PCR amplification and DNA sequencing were performed at the Canadian Centre for DNA Barcoding following standard high-throughput protocols (which can be accessed at http://www.dnabarcoding.ca/pa/ge/research/protocols), where all obtained DNA extracts are stored now. All sequences were deposited in GenBank according to the iBOL data release policy. Complete specimen data (images, voucher deposition, geographic coordinates, sequence and trace files) can easily be accessed in the BOLD in public project ZYGMO [http://www.boldsystems.org/index.php/MAS_Management_OpenProject?code=ZYGMO]. Sequence divergences for the barcode region were calculated using the Kimura 2 Parameter model by the analytical tools on BOLD.

Results

The conspecificity of the collected males with the holotype of *Zygaenorpocris eberti* was confirmed by the analysis of the DNA barcode, 658-bp region of the cytochrome *c* oxidase I mitochondrial gene (Fig. 5). The treeless habitat at Band-i Amir, Jarkushan N, Hazarajat, 3130–3280

m (Fig. 3), was dominated by *Acantholimon* (Plumbaginaceae), *Cousinia*, *Artemisia* (Asteraceae) and *Astragalus* (Fabaceae) species. As we know from other *Zygaenoprocris* (*Zygaenoprocris*) species, *Acantholimon* and *Cousinia* may be the larval host-plants for the studied species. We provide below a description of the hitherto unknown male of *Z. eberti*.

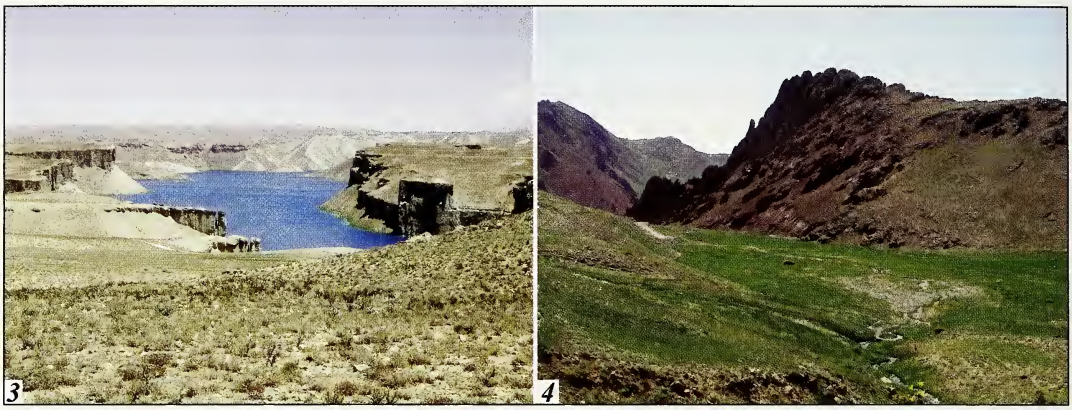
Zygaenoprocris eberti (Alberti, 1968)

Description of male (Fig. 1). Length of body: 5.8–6.5 mm; length of forewing: 8.6–8.9 mm, width: 3.3–3.4 mm; length of antenna: 4.6–5.0 mm. Frons and occiput green with submetallic sheen. Antenna strongly clubbed, thickly covered with shining scales, bipectinate, length of pectination in middle part of antenna 0.7 mm, last segments of antenna with pectination reduced, antennal shaft strongly thickened distally, ratio of width of 4th segment from apex to width of 15th segment is 4. Proboscis well developed, yellow. Tegulae and patagia green with submetallic sheen. Thorax thickly covered with green shiny scales. Forewing upperside bright green with submetallic sheen, thickly covered with shiny scales; underside of forewing grey; fringe grey. Hindwing upper- and underside grey, fringe concolorous. Legs green, thickly covered with shiny scales, foreleg with long tibial epiphysis, hind tibia with one pair of spurs (apical). Abdomen greenish black, thickly covered with shiny scales. The long black hair covers the head, labial palpi, thorax, legs and abdomen.

Male genitalia (Figs 6, 8). Uncus heavily sclerotized, nearly equal in length to tegumen. Valva without any process. Juxta long, 1.5 times longer than uncus. Phallus slightly curved, long, approximately 3 times longer than uncus, with one long straight cornutus, its length 0.5 times length of phallus, distal part of cornutus very slender, with pointed apex.

Differential diagnosis. *Zygaenoprocris eberti* is syntopic and synchronous with *Zygaenoprocris* (*Zygaenoprocris*) *chalcochlora* Hampson, 1900, the type species of the subgenus *Zygaenoprocris* Hampson, 1900. Externally these two species cannot be distinguished but both differ significantly in their genitalia morphology (Figs 6–8; Efetov and Tarmann 1999, figs 108, 166). In the male the phallus is longer in *Z. eberti* and the cornutus is large with a characteristic shape

Figures 1, 2. 1. Male of *Zygaenoprocris eberti* (Alberti, 1968). Afghanistan, Prov. Bamiyan, Band-i Amir, Jarkushan N, 3130–3280 m, 5.vii.2011, leg. A. Hofmann. Photo S. Heim. **2.** Mixture of (2*R*)-butyl (7*Z*)-dodecenoate and (2*R*)-butyl (9*Z*)-tetradecenoate ('R12+R14') attracting two males of *Zygaenoprocris eberti* (Alberti, 1968). The two males were so sexually excited that they copulated with each other. Afghanistan, Prov. Bamiyan, Band-i Amir, Jarkushan N, 3130–3280 m, 5.vii. 2011. Photo A. Hofmann.



Figures 3, 4. 3. Habitat of *Zygaenoprocris eberti* (Alberti, 1968), and *Zygaenoprocris chalcochlora* Hampson, 1900. Afghanistan, Prov. Bamiyan, Band-i Amir, Jarkushan N, 3130–3280 m, 5.vii. 2011. Photo A. Hofmann. **4.** Near the type locality of *Zygaenoprocris eberti* (Alberti, 1968). Afghanistan, Prov. Bamiyan, Koh-i Baba, Shahtu pass, 3000 m. The exact type locality is not known. Photo A. Hofmann.

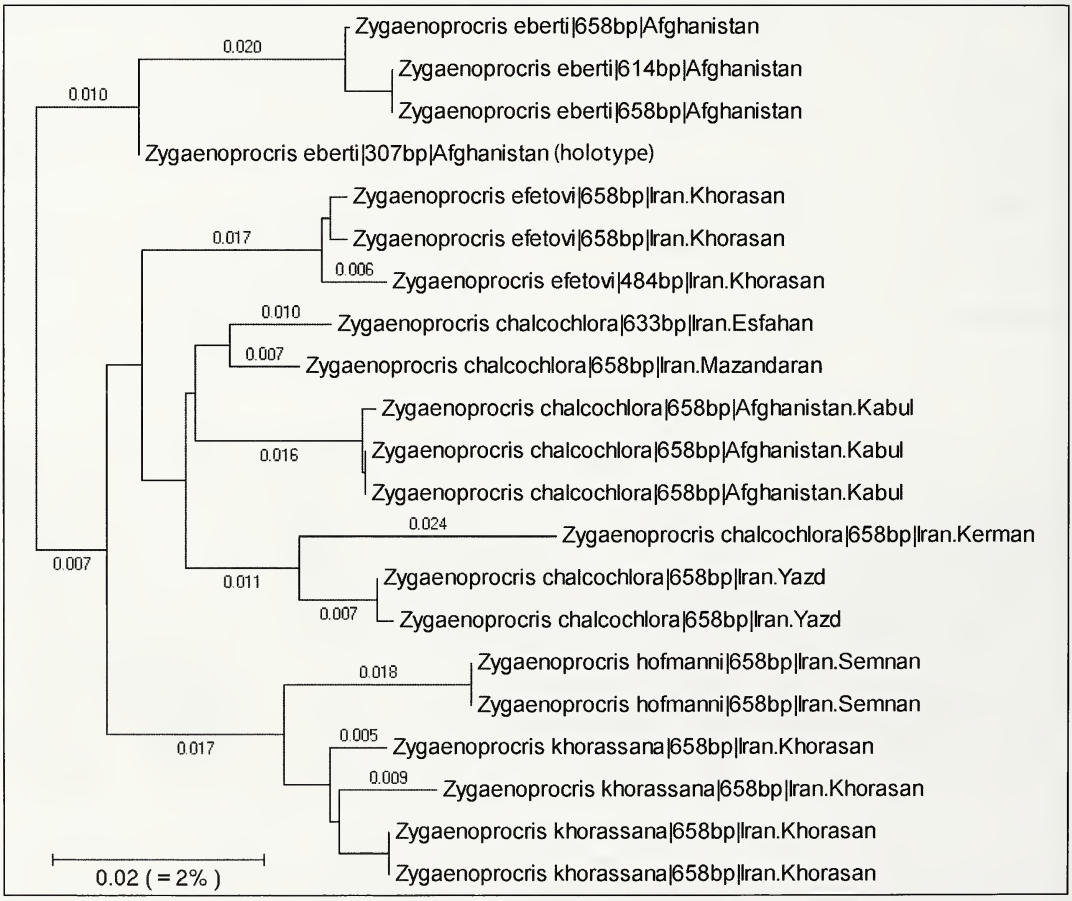


Figure 5. Neighbour-joining tree (K2P) of the DNA barcodes for the different *Zygaenoprocris* (*Zygaenoprocris*) species.

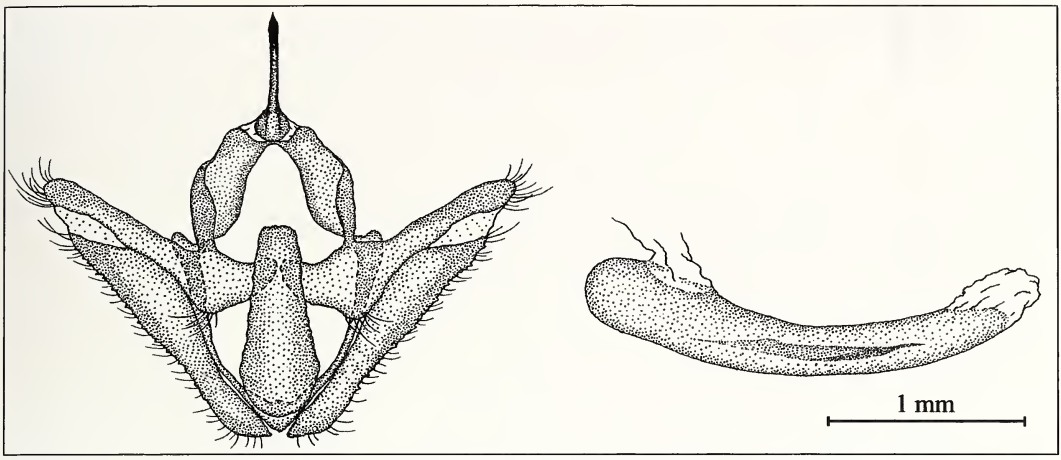


Figure 6. Male genitalia of *Zygaenoprocris eberti*. Afghanistan, Prov. Bamiyan, Band-i Amir, Jarkushan N, 3130-3280 m, 5.vii. 2011, leg. A. Hofmann.

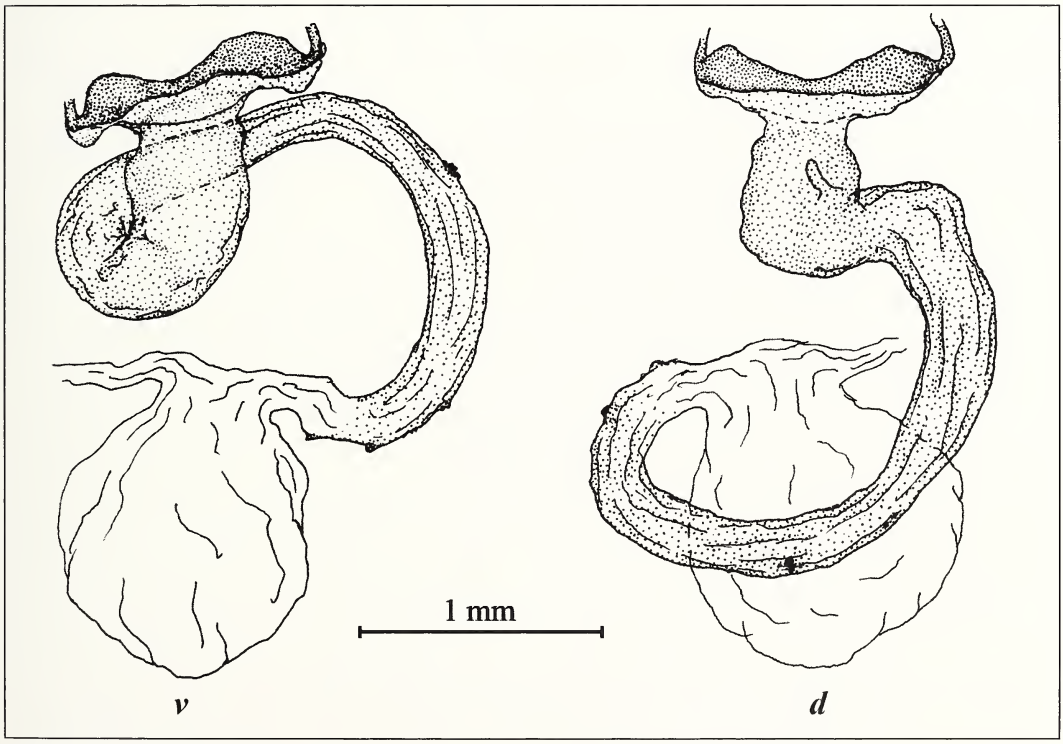
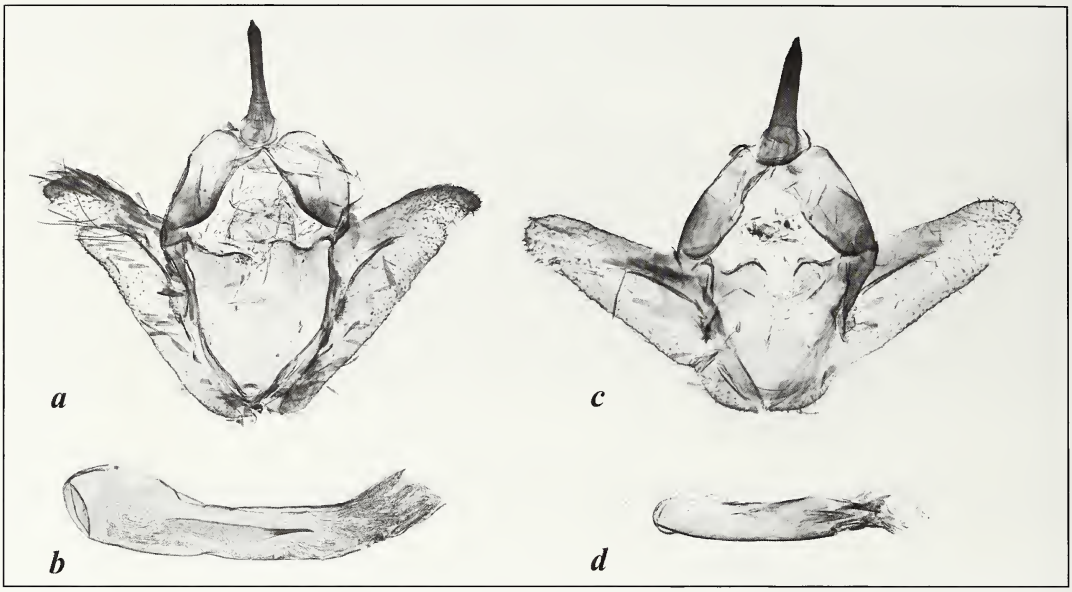


Figure 7. Female genitalia of the holotype of *Procris eberti* Alberti, 1968 (= *Zygaenoprocris eberti*), *v* – ventral view, *d* – dorsal view. 'Z.-Afghanistan, Koh-i-Baba, S-Seite Shahtu-Pass, 3000 m, 17.–19.7.1966, G. EBERT leg.'

(with broad basal part and ending somewhat abruptly in a pointed tip distally). The female of *Z. eberti* has long, broad and strongly curved (twisted) ductus bursae, whereas *Z. chalcochlora* has short, narrow and straight ductus bursae.



Figures 8a–d. a, b. Male genitalia of *Zygaenoprocris eberti*. Afghanistan, Prov. Bamiyan, Band-i Amir, Jarkushan N, 3130–3280 m, 5.vii. 2011, leg. A. Hofmann (Prep. GMT Z 3562). **a**, Uncus, tegumen, vinculum, saccus, valvae; **b**, Phallus (Photo S. Heim). **c**, **d**. Male genitalia of *Zygaenoprocris chalcochlora*. Afghanistan, Prov. Kabul, Kabul N, Darreh Estalif, 1880–2200 m, 21. vi. 2011, leg. A. Hofmann (Prep. GMT Z 3564). **c**, Uncus, tegumen, vinculum, saccus, valvae; **d**, Phallus (Photo S. Heim).

Remarks. As shown earlier, males of *Zygaenoprocris* (*Molletia*) *taftana* (Alberti, 1939), were attracted by (2*R*)-butyl (7*Z*)-dodecenoate (Efetov et al. 2011). Males of *Zygaenoprocris* (*Zygaenoprocris*) *eberti* were attracted by (2*R*)-butyl (7*Z*)-dodecenoate ('R12') as well as by the mixture of (2*R*)-butyl (7*Z*)-dodecenoate and (2*R*)-butyl (9*Z*)-tetradecenoate ('R12+R14') (Fig. 2). Of the 38 males that were collected at both attractants 28 were taken around or on the R12 pheromone baits and 10 around or on the baits with the mixture of R12+R14. Of the 13 dissected specimens taken at R12, 12 were *Z. eberti* and only one *Z. chalcochlora*. All 10 specimens attracted to R12+R14 were *Z. eberti*. The collecting time was between 13.15–14.15 hours.

Key to the subgenera of the genus *Zygaenoprocris* Hampson, 1900

1 Valva extremely narrow (Efetov and Tarmann 1999: figs 113–115; Efetov 2001a: fig. 11) ..... subgenus ***Molletia*** Efetov, 2001a

– Valva broad (Efetov and Tarmann 1999: figs 108–112; Efetov 2001a: figs 10, 12) 2

2 Apex of sacculus with triangular, pointed process (Efetov and Tarmann 1999: figs 111, 112; Efetov 2001a: fig. 12), ductus bursae with sclerotized spines (Efetov and Tarmann 1999: figs 169–171; Efetov 2001a: fig. 15) ..... subgenus ***Keilia*** Efetov, 2001a

Figure 9. Male of *Zygaenoprocris chalcochlora* Hampson, 1900, resting on *Artemisia*. Afghanistan, Prov. Baghlan, Salang pass, north side, Do Shagh N, Chahar Maghzak vic., 2180–2250 m, 22.vi. 2011. Photo A. Hofmann.

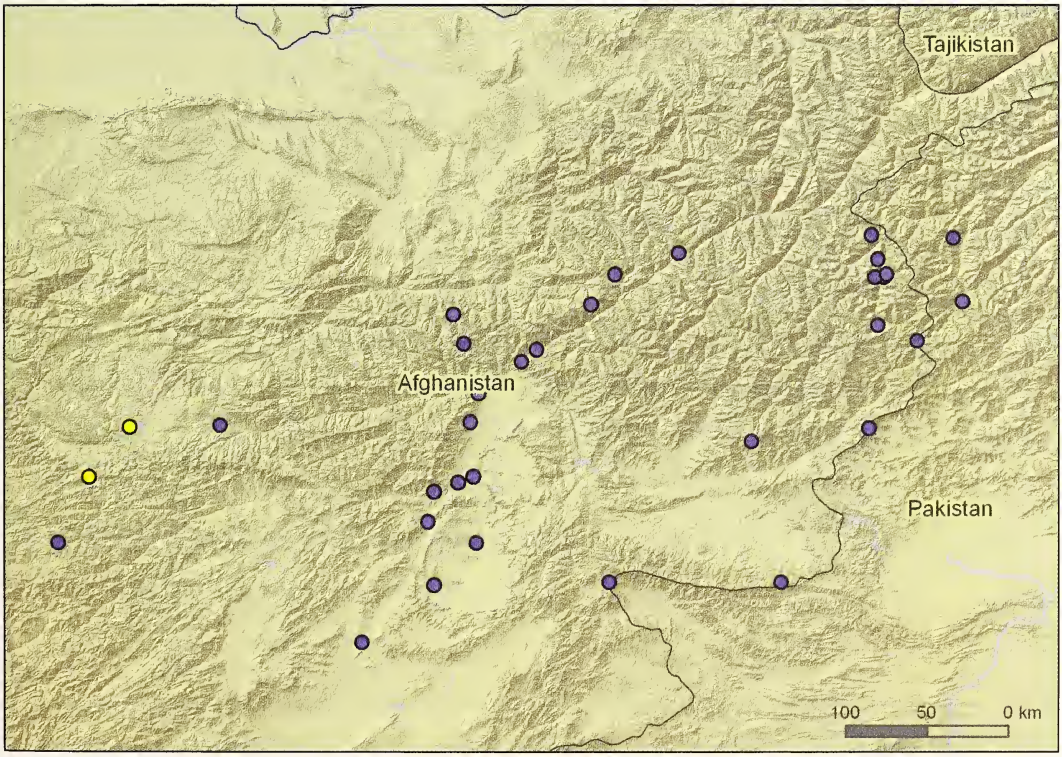


Figure 10. Distribution map of *Zygaenoprocris eberti* and *Z. chalcochlora* in Afghanistan. Blue dots: *Z. chalcochlora*, yellow dots: *Z. eberti* (at the northern locality of *Z. eberti* this species is syntopic with *Z. chalcochlora*).

– Apex of sacculus without triangular, pointed process (Efetov and Tarmann 1999: figs 108–110; Efetov 2001a: fig. 10), ductus bursae without sclerotized spines (Efetov and Tarmann 1999: figs 166–168; Efetov 2001a: fig. 13; Mollet 2003: fig. 2).....3

3 Distal end of phallus with two very characteristic lateral processes with sclerotized dentations apically (Efetov and Tarmann 1999: fig. 110), ductus bursae strongly dilated, forming a praebursa (Mollet 2003: fig. 2)..... subgenus ***Efetovia*** Mollet, 2001

– Distal end of phallus without lateral processes (Efetov and Tarmann 1999: figs 108, 109), ductus bursae not forming a praebursa (Efetov and Tarmann 1999: figs 166–168; Efetov 2001a: fig. 13).....subgenus ***Zygaenoprocris*** Hampson, 1900

Key to the species of the subgenus *Zygaenoprocris* Hampson, 1900

1 Forewing upperside green, bluish green or coppery, with submetallic sheen Figs 1, 9).....2

– Forewing upperside light brown, without submetallic sheen 5

2 Cornutus short, slightly sclerotized (Fig. 8d, Efetov and Tarmann 1994: figs 56–60; 1999: fig. 108; Efetov 2001a: fig. 10), ductus bursae not twisted (Efetov and Tarmann 1999: fig. 166; Efetov 2001a: fig. 13).....3

– Cornutus long, strongly sclerotized (Figs 6, 8b; Efetov and Tarmann 1999: fig. 109), ductus bursae twisted (Fig. 7; Efetov and Tarmann 1999: figs 167, 168).....4

3 Papillae anales narrow, apophyses posteriores long (Mollet and Tarmann 2007: fig. 10) .....***Z. (Z.) chalcochlora*** Hampson, 1900

– Papillae anales broad, apophyses posteriores short .....
.....***Z. (Z.) khorassana*** (Alberti, 1939)

4 Cornutus very long (2.5 times longer than uncus), juxta with sclerotized spines ventrally (Efetov 1996: figs 5, 6; Efetov and Tarmann 1999: figs 109, 109a), ductus bursae narrow, distal part of ductus bursae with smooth walls (Efetov 1996: fig.7; Efetov and Tarmann 1999: fig. 167)..... ***Z. (Z.) rjabovi*** (Alberti, 1938)

– Cornutus shorter (only 1.8 times longer than uncus), juxta without sclerotized spines (Fig. 6), ductus bursae broad, distal part of ductus bursae with folded walls (Fig. 7; Efetov 1996: figs 8, 9; Efetov and Tarmann 1999: fig 168).....***Z. (Z.) eberti*** (Alberti, 1968)

5 Cornutus 6 times shorter than phallus, apex of cornutus obtuse (Mollet and Tarmann 2007: fig. 6).....***Z. (Z.) hofmanni*** Mollet & Tarmann, 2007

– Cornutus only 3 times shorter than phallus, apex of cornutus pointed (Mollet and Tarmann 2007: fig. 5).....***Z. (Z.) efetovi*** Mollet & Tarmann, 2007

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Phyllobrostis minoica sp. n. from Crete (Greece) – an expected discovery (Lepidoptera, Yponomeutoidea, Lyonetiidae)

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*http://zoobank.org/*0A007CAE-38E8-43D3-B5AA-5E7D15BCFA07

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Subject Editor: Lauri Kaila.

Abstract. *Phyllobrostis minoica* sp. n. is described from Crete, Greece. It belongs to the *P. daphneella* group and seems to be related to *P. jedmella* Chrétien. The two species are clearly distinguishable by the external characters and by the male genitalia. The adult habitus and male and female genitalia of the new species are illustrated.

Introduction

Species of the genus *Phyllobrostis* Staudinger, 1859 occur in Europe, the Middle East and southern Africa. This group was revised by Mey (2006), and a total of 11 species were recognised. A recent addition was *P. peninsulae* Mey, 2011 described from the Cape of Good Hope, South Africa (Mey 2011). The disjunctive distribution in three intercontinentally separated sub-ranges is a remarkable feature of the genus. While the isolation of the South African area from the Palaearctic Region appears to reflect reality, the wide distribution gap between Europe and the Middle East sub-range is probably an artifact due to under-collecting in the intermediate countries. The larvae are leaf miners and twig borers of *Daphne* spp. and *Thymelaea* spp. (Thymelaeaceae). Larval host plants of these moths are widely distributed throughout the Mediterranean Region and from West Asia to Japan. On the Balkan Peninsula and in Turkey several species of *Daphne* are known, which could serve as host plants of *Phyllobrostis* species, but the genus has not been recorded from those localities until now. Two excursions were conducted by the author to Turkey in search of *Phyllobrostis*, but without any success so far. Nonetheless, since there are no discernible ecological and geographical barriers on both sides of the Mediterranean Sea (southern Europe and northern Africa), the genus could be expected to have a continuous distribution with species occurring at least on the Balkan Peninsula and in Turkey. The discovery of such species was predicted (Mey 2006: p. 141), and it seemed to be only a matter of time until they are found. The herein presented description of a new *Phyllobrostis* species proves the prediction to be true. Crete is situated in the distributional gap and the record increases the probability of the existence of species in continental Greece as well.

Phyllobrostis minoica sp. n.

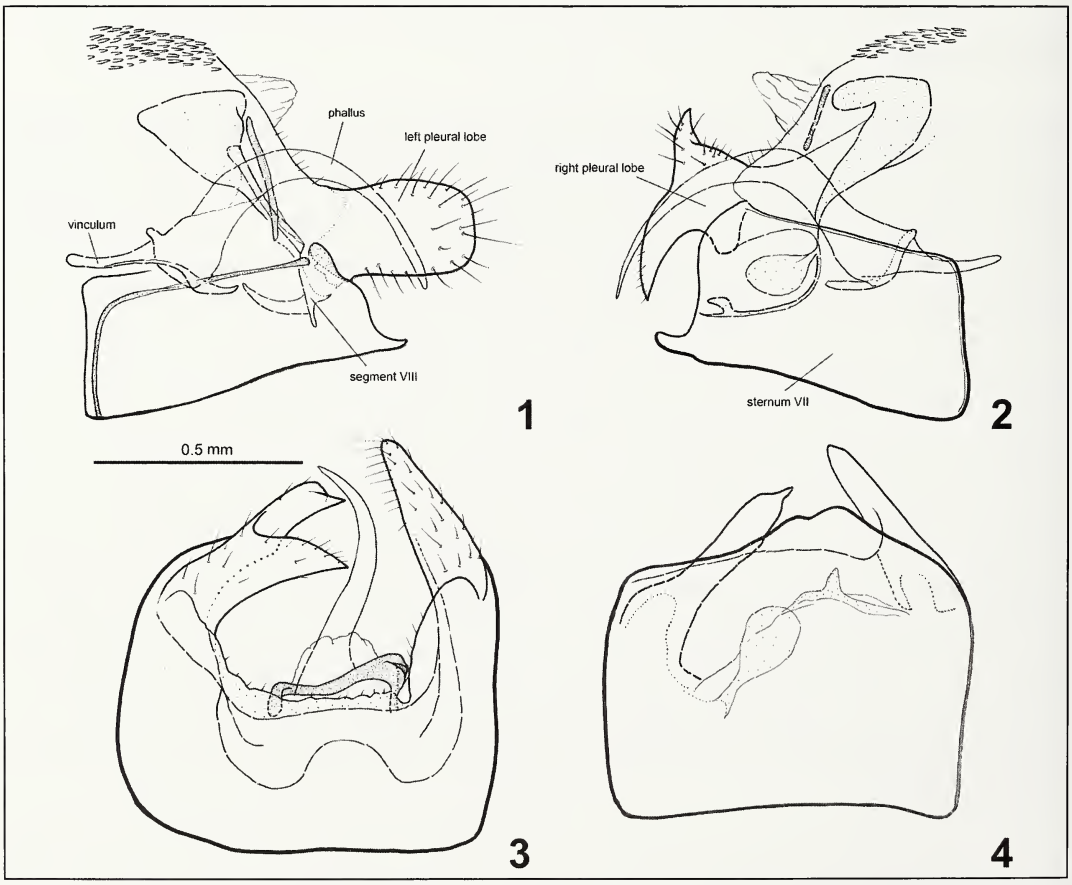
http://zoobank.org/8B85D3AB-FC0E-4304-BD61-3F7898E0A5B4

Material examined. Holotype ♂, "Hellas, Crete/ Nom. Chania/ 35°21'11"N, 23°54'39"E/ N of Omalos plateau/ at pass, 1150m/ 7.6.2004/ leg. B. Skule, C. Hviid/ & E. Vesterhede", coll. ZMUC Copenhagen, Denmark. Paratypes: 1 ♀, same data as holotype, 1 ♂, 2 ♀♀, same locality as holotype, but collected on 11.vi. 2004, genitalia slide Mey 13/13 (♂) and Mey 3/14 (♀), Museum für Naturkunde, Berlin.

Derivatio nominis. The specific name is derived from "Minos", legendary king in Crete and the Minoic culture on the island in the 2nd millennium B.C., which is considered the cradle of civilization in Europe.

Description. The general characters of the new species are in agreement with the diagnosis of the genus (Mey 2006). Only unique and diagnostic characters of the new species are treated and described here.

Adult (Fig. 7). Forewing length 3.5–4.5 mm, wing span 8.8–9.5 mm. Head pale grey, with a yellow shine. Antennae grey, not annulated, thicker in males than in females, flagellomeres with



Figures 1–4. Male genitalia of *P. minoica* sp. n. **1** Lateral view, left side **2** Lateral view, right side **3** Dorsal view **4** Ventral view.

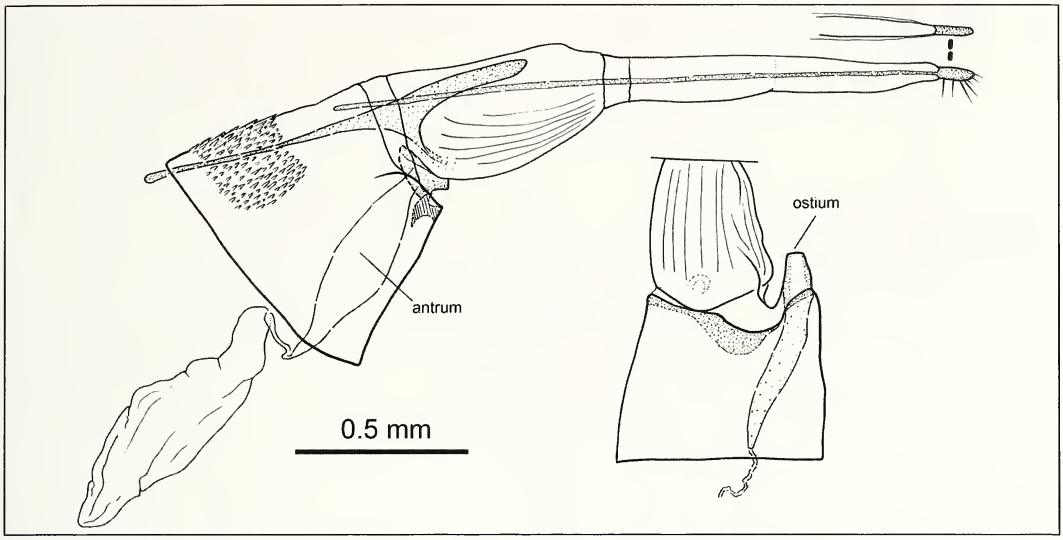


Figure 5. Female genitalia of *P. minoica* sp. n., lateral view and ventral view of segments VII and VIII.

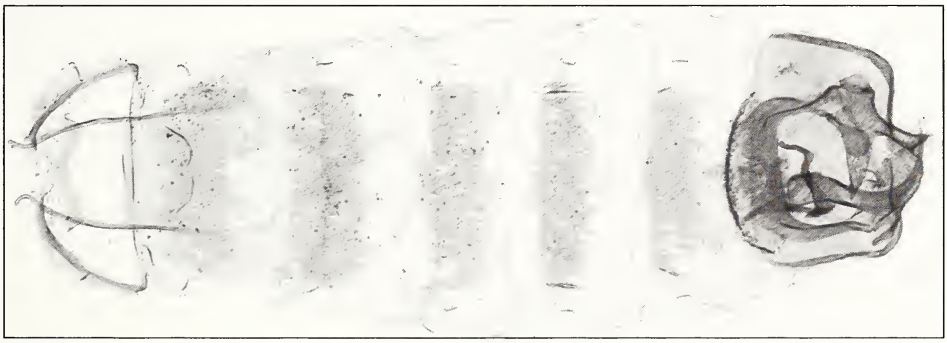


Figure 6. Male abdomen of *P. minoica* sp. n. (genitalia slide Mey 13/13).

complete annulus of slender scales, very short cilia present at ventro-lateral bases of flagellomeres. Piliform scales present behind scape and eye margin. Labial palpi as long as diameter of eye, slender and straight, two distal segments visible, covered with broad, pale grey scales. Thorax and forewings pale grey, fringes slightly paler, forewing scales with pale tips, hindwing scales of same colour as forewing scales. Male with one, female with two frenular bristles. Legs pale grey, subapical spurs of hindtibia before middle as seen from femur. Abdomen on upper and underside pale grey, spined terga from segment III to IV pale orange-brown.

Male genitalia (Figs 1–4, 6). Genital segments asymmetrical, sternum VII short, distal margin rounded, slightly protruding in the middle and terminating with a somewhat notched tip. Sternum VIII a membranous layer on the dorsal side of sternum VII, connected laterally with pleural lobes. Pleural lobes large, left one rectangular, rounded, right one bifid, with dorsally and ventrally directed, triangular parts, acute at tips in dorsal and lateral view. Vinculum greatly reduced, fused with saccus anteriorly to form a short, broad process. Saccus attached to phallus, extending anteriorly

Figure 7. Female paratype of *P. minoica* sp. n. (Scale bar: 2 mm).

into segment VI. Teguminal complex inside segment VII, consisting of a ring-like structure around anal tube. Phallus tubular, long and acute apically, curved ventrad, cornuti absent.

Female genitalia (Fig. 5). Segment VII asymmetrical, distal margin on ventral side irregularly excised and sclerotized, with a protruding genital opening at tip of a conical process attached laterally on the right side to segment VII. Antrum tubular, extending anteriorly to beyond segment VII, narrowed at base, ductus bursae long and somewhat winding, entering elongate and oval bursa at distal apex, signum absent. Ovipositor (segment VIII+IX) telescopic, segment VIII membranous ventrally, with thin, parallel stripes or folds, laterally sclerotized by enlarged, distal ends of apophyses anteriores (a.a.). Apophyses posteriores twice as long as a.a. and fused apically into a short, sclerotized cone (fused papillae anales) with thin bristles on the ventral side.

Remarks. The new species belongs to the *P. daphneella* group, which is defined by complete loss of the valvae, a rudimentary gnathos and the small labial palpi (Mey 2006). The latter character is somewhat different in *P. minoica* sp. n. as its labial palpi are longer and clearly visible, but not as large as in the species of the *P. eremitella* group. External characters of the new species resemble those of *P. jedmella* Chrétien, 1907, known from Algeria and Spain. Also, the male genitalia of both species are similar. The main distinguishing traits are the shape of the ventral margin of segment VII, the strongly asymmetric pleural lobes of *P. minoica* sp. n. and the tergum VII with shorter spiniform setae in *P. jedmella*. In the female genitalia, the asymmetric segment VII with a protruding cone bearing the distal part of the antrum and the ostium represent a character observed in the genus for the first time. Unfortunately, the female of *P. jedmella* is unknown; however, *P. minoica* sp. n. female can be expected to be similar to it if the two species are indeed close relatives.

Acknowledgements

While visiting the Lepidoptera collection in the Zoological Museum in Copenhagen, Ole Karsholt drew my attention to the material of the new species. I am greatly indebted to him and the collectors of the new species, B. Skule, C. Hviid and E. Vesterheide. My thanks go to J. Dunlop who corrected the English text and to L. Kaila, who edited the manuscript.

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Contribution to the knowledge of the genus *Zygaena* Fabricius, 1775, in Iran (Lepidoptera, Zygaenidae). Part X: On two newly discovered *Mesembrynus* taxa from the western Alborz

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Abstract. Two well-defined *Zygaena* taxa are described from the central Alborz range in Iran and are placed as subspecies of two known *Mesembrynus* species. Both taxa inhabit biotopes on the northern side of the main Alborz range, areas that are climatically influenced by the Caspian Sea. *Zygaena speciosa oseyii* ssp. n. is represented by the most north-westerly populations of *Z. speciosa* Reiss, 1937, from Kuh-e Samamus, Gardaneh-ye Tondrokosh and from Kuh-e Khash-Chal, all of which are characterized by the absence of melanistic forms, while the nominotypical populations exhibit only melanistic forms. *Zygaena tamara dailamica* ssp. n. differs from all known populations of *Z. tamara* by having a different red coloration while the red abdominal cingulum is restricted to one segment. Moreover, consistent differences are found in the larval phenotype although several cross-breedings (*Z. tamara tamara* Christoph, 1889 × *Z. tamara dailamica* ssp. n.) were successful.

Zusammenfassung. Aus dem zentralen Elbursgebirge/Iran werden zwei außergewöhnliche *Zygaena*-Taxa beschrieben und bereits bekannten *Mesembrynus*-Arten subspezifisch zugeordnet. Die Fundorte beider Taxa befinden sich nördlich des Elburs-Hauptkammes; sie sind klimatisch bereits vom Kaspischen Meer beeinflußt. Zu *Zygaena speciosa oseyii* ssp. n. ziehen wir die nordwestlichsten Populationen vom Kuh-e Samamus, vom Gardaneh-ye Tondrokosh und vom Kuh-e Khash-Chal. Diese Populationen unterscheiden sich von der Nominatform durch das Fehlen melanistischer Formen. *Zygaena tamara dailamica* ssp. n. weicht von allen bekannten *Z. tamara*-Population durch eine andere Rotfärbung so wie durch einen stets einfachen, roten Abdominalring ab. Auch im Raupenphänon bestehen konstante Unterschiede; Kreuzungsversuche (*Z. tamara tamara* Christoph, 1889 × *Z. tamara dailamica* ssp. n.) verliefen jedoch erfolgreich.

Introduction

Currently the family Zygaenidae is subdivided into four subfamilies (Chalcosiinae, Procridinae, Callizygaeninae, Zygaeninae) of which Zygaeninae comprises two Palaearctic (*Zygaena, Pryeria* Moore, 1877), one Oriental (*Epizygaenella* Tremewan & Povolný, 1968) and six Afrotropical genera (*Reissita* Tremewan, 1959, *Epiorna* Alberti, 1954, *Orna* Kirby, 1892, *Zutulba* Kirby, 1892, *Praezygaena* Alberti, 1954, *Neurosymploca* Wallengren, 1858). The most species-rich genus *Zygaena*, with 108 currently recognised species (Hofmann and Tremewan 2010), has its recent centres of high diversity in the western Mediterranean region, Iran and Central Asia. Species of this

group are found from sea-level up to more than 4500 m in altitude. The highlands of Iran and Central Asia are especially rich in high-mountain endemics.

On June 25, 2006, A. Naderi discovered near the top of Kuh-e Samamus (3687 m) south-east of Ramsar (Iran), at an altitude of *ca.* 3350 m a new and extraordinarily distinct population of *Z. speciosa*, a high-mountain species that is endemic to Iran. Two weeks later, A. Naderi & A. Hofmann undertook fieldwork at this locality. Before reaching the village of Javaherdeh, which is located at the foot of Kuh-e Samamus, we crossed the Alborz Range via two passes between Qazvin and the Caspian plain between13.–15.7.2006, the road consisting partly of a very bad gravel road. North-east of Hir we collected near Gardaneh-ye Ambarkesh (2500 m), further north in the vicinity of Tamol and then in the vicinity of Gardaneh-ye Tondrokosh (3100 m). At all of these localities we found another taxon that could not be referred to any known species at that time. The colour reminded us of *Z. tamara*, but the abdominal cingulum was present only on one segment, a character that is consistently different in all populations of *Z. tamara*, independently of whether they are red/red, red/yellow or yellow/yellow (Naumann 1987: 210, fig. 9, Hofmann and Tremewan 2001). *Zygaena tamara* Christoph, 1889, is a widely distributed, polymorphic and polytypic burnet moth occurring in western Iran, Armenia, Azerbaijan, eastern Turkey and northern Iraq (Naumann 1987: 211, fig. 10). In the Alborz range the species is uncommon and its range obviously does not extend further east than the vicinity of Semnan. In the central Alborz no populations are recorded from the north side of the main mountain chain which is influenced by the Caspian climate. Based on its recent distribution, Naumann (1987: 207) characterised *Z. tamara* as an Irano-eremic faunal element.

Methods

More general introductions of the topic for a whole series of papers can be found in Hofmann (2000a) and Hofmann and Kia-Hofmann (2008). The results recorded in the present paper are based on fieldwork in Iran, successfully reared ab-ovo cultures (in Germany; Hofmann and Kia-Hofmann 2008, 2011) and genitalia dissections. Using the standard method of preparation (Robinson 1976), the genitalia were examined, embedded in Euparal on permanent microscopic slides and photographed with a digital stereo-microscope (G. Tarmann, Innsbruck, Austria). Dissected specimens with slides are deposited in CAHO. The terminology of the genitalia structures follows that of Alberti (1958: 263–268); for the terminology of the forewing pattern see Alberti (1958: 258), Tremewan (1985: 102) and Hofmann (2003: 53).

Abbreviations

CAHO	Collection Axel Hofmann, Linkenheim-Hochstetten, Germany.
CWGT	Collection W. Gerald Tremewan, Truro, Great Britain.
CV	used for chronological reference of cultures in captivity; it means "Copula-Versuch" or beginning of 'curriculum vitae', e.g. CV070604 began with a copula on 4 June 2007.
HMIM	Hayk Mirzayans Insect Museum, Tehran, Iran.
SMNK	Staatliches Museum für Naturkunde Karlsruhe, Germany.

Table 1. List of localities in Iran.

Zygaena speciosa oseyii ssp. n.	Prov. Gilan, Kuh-e Samamus, Javaherdeh 20 km SSW.	3350 – 3400 m	36°50.92′N	50°23.66′E
Zygaena speciosa oseyii ssp. n.	Prov. Mazandaran, Tonekabon SW., Gardaneh-ye Tondrokosh (Zarout)	3270– 3350 m	36°41.76′N	50°29.77′E
Zygaena speciosa oseyii ssp. n.	Prov. Qazvin NE., Mo'allem Kalayeh, vic., Kuh-e Khash-Chal	3390–3430 m	36°32.53′N	50°30.31′E
Zygaena tamara dailamica ssp. n.	Prov. Qazvin, Hir NE., Gardaneh-ye Anbarkesh, N. side	2780–2900 m	36°37.46′N	50°21.34′E
Zygaena tamara dailamica ssp. n.	Prov. Mazandaran, Tonekabon SW., Tamol vic.	2250–2400 m	36°38.87′N	50°25.71′E
Zygaena tamara dailamica ssp. n.	Prov. Mazandaran, Tonekabon SW., Gardaneh-ye Tondrokosh (Zarout) N.	2800–3000 m	36°41.35′N	50°31.96′E

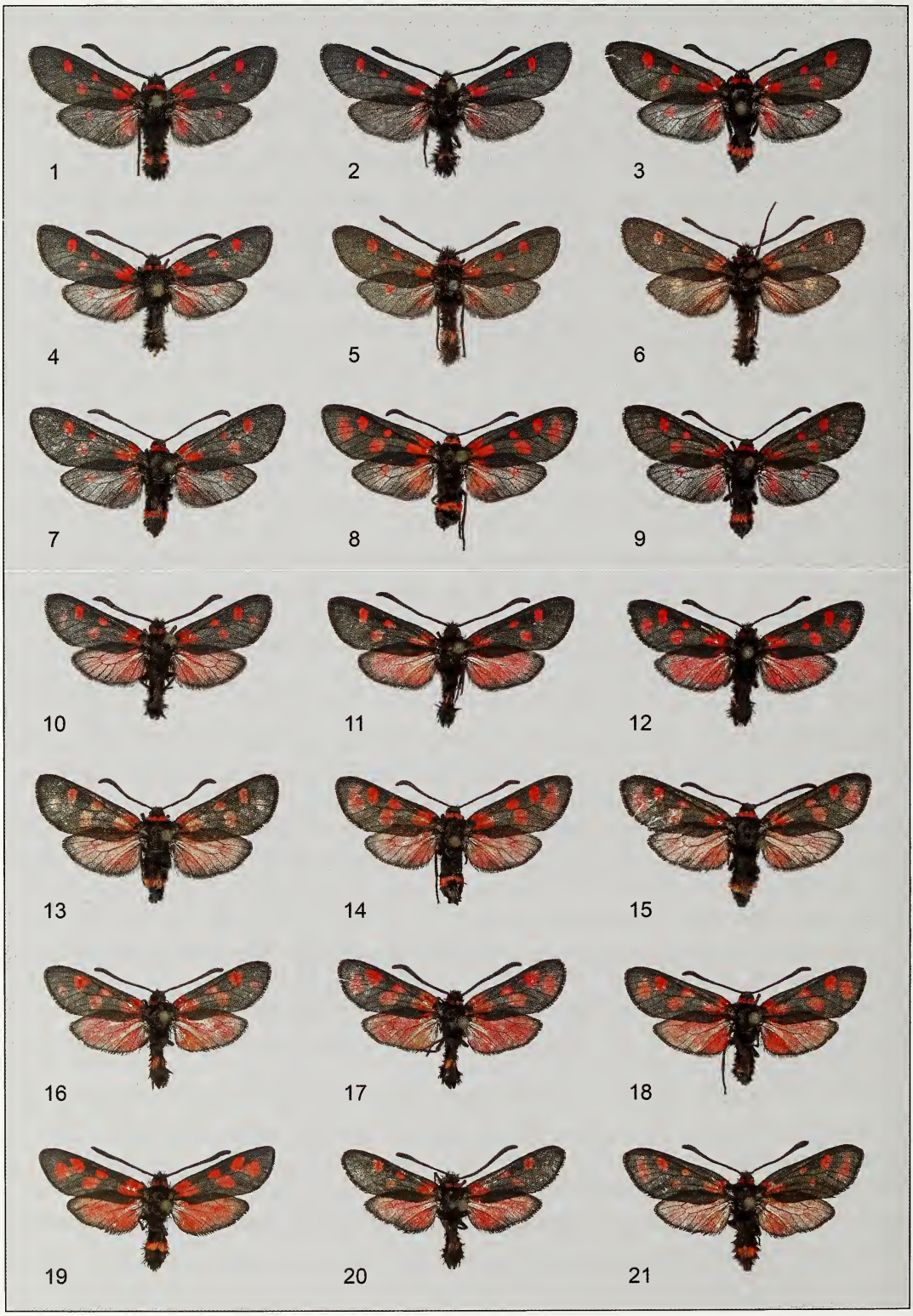
The high-mountain *Mesembrynus*-species of the Alborz Range (Iran)

Traditionally the genus *Zygaena* comprises three subgenera, *Agrumenia* Hübner, [1819], *Zygaena,* and *Mesembrynus* Hübner, [1819], but only the last subgenus appears to be a well-defined monophylum based on molecular data (Niehuis et al. 2007). In contrast to the other two paraphyletic subgenera, the larvae of *Mesembrynus* live on acyanogenic plants, mainly Apiaceae (only a few species secondarily switched to Lamiaceae and Asteraceae).

Naumann (2000) and Hofmann (2000) have provided detailed information on the rediscovery (the latter author also on the biology) of *Zygaena cacuminum* Christoph, 1877, in the Shah-Kuh region, while Hofmann and Kia-Hofmann (2008) have described the bionomics and distribution of *Z. speciosa* Reiss, 1937, both of these taxa being closely related, endemic Iranian species that are restricted to the oreal biome of the Alborz Range where *Z. cacuminum* inhabits cushion zone biotopes in the eastern Alborz, while *Z. speciosa* has been recorded only from the central part. As each species was known only from a single locality before 2001 (Hofmann and Kia-Hofmann 2008: 35), both were regarded at that time as unilocal and monotypic. However, Hofmann and Kia-Hofmann (2008) recorded new locality data and were able to show that neither of these species is restricted to a single site.

Zygaena speciosa and *Z. cacuminum* are geographically well separated, a wide gap of *ca.* 250 km existing between Shah-Kuh and the Kuh-e Damavand. Phenotypically, *Z. cacuminum* is distinguished by having on the forewings a quadrangular spot 4, a well-developed spot 6 and especially by the lack of melanistic tendencies on the hindwings. Hitherto, both high-mountain species were considered to be monotypic and represented only by populations consisting of very similar phenotypes.

On several expeditions to the central and western Alborz in 2006 and 2010 the authors had the opportunity to accrue new data on the *tamara*-like populations and also on *Z. speciosa*; those on the latter were partly incorporated in an earlier publication (Hofmann and Kia-Hofmann 2008). Of great taxonomic and zoogeographical interest are these most westerly populations, as they show that *Z. speciosa* actually is a polytypic species with a second subrange which is inhabited by purely non-melanistic populations.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Zygaena speciosa Reiss, 1937

Figs 1–39

Remarks. Described from the Alam-Kuh region, the melanistic form (*Z. speciosa speciosa*) is currently known from seven localities between Kuh-e Demavand in the east and Alam Kuh in the west, while non-melanistic populations were unknown until now and are here recorded for the first time from three localities located between Mo'allem Kalayeh (Qazvin NE.) and Kuh-e Samamus.

Zygaena speciosa oseyii ssp. n.

Figs 10–29, 33–35, 38, 39

Material. Holotype ♂, 28 mm wingspan, "Iran, Prov. Gilan, Kuh-e Samamus, Javaherdeh 20 km SSW, 3350–3400 m, 30.6.2006, leg. A. Hofmann & A. Naderi", [36°50,92' N, 50°23,66'E], coll. A. Hofmann (to be deposited in SMNK). Paratypes: 1 ♂, 2 ♀, same data as holotype, coll. A. Hofmann; same locality as holotype: 35 ♂, 18 ♀, 15.vii. 2006, leg. et coll. A. Hofmann; 1 ♂, coll. J. Mooser; 1 ♂, coll. A. Floriani; 7 ♂, 3 ♀, coll. T. Keil; 4 ♂, 1 ♀, leg. larvae, e.p.: 30.vi.–10.vii.2006 leg. et cult. A. Hofmann, coll. A. Hofmann; 3 ♂, 2 ♀, 25.vi. 2006, leg. A. Naderi, coll. A. Hofmann; 8 ♂, leg. et coll. A. Naderi; 16 ♂, 3 ♀, 3.viii.2007, leg. et coll. A. Naderi; 3 ♂, 1 ♀, coll. A. Hofmann; 7 ♂, 1 ♀, coll. T. Keil; 4 ♂, coll. P. Zehzad (to be deposited in HMIM). Other material: Iran, Prov. Mazandaran, Tonekabon SW, Gardaneh-ye Tondrokosh (Zarout), 3270–3350 m, [36°41,76'N, 50°29,77'E], 17 ♂, 2 ♀, 14.vii.2006, leg. A. Hofmann & A. Naderi, coll. A. Hofmann; 3 ♂, ibidem, coll. T. Keil; 2 ♂, ibidem, 10.vii.2007, leg. A. Naderi, coll. T. Keil; 5 ♂, 2 ♀, ibidem, 13. u. 14.vii.2010, leg. et coll. A. Hofmann; this locality is about 20 km southeast of Kuh-e Samamus. Iran, Prov. Qazvin NE, Mo'allem Kalayeh vic., Kuh-e Khash-Chal, 3390–3430 m, [36°32,53'N, 50°30,31'E], 11 ♂, 1 ♀, 15.vii.2010, leg. et coll. A. Hofmann; 11 ♂, 10 ♀, ibidem, 3550–3700 m, leg. et coll. A. Hofmann; this locality is about 35 km southeast of Kuh-e Samamus.

Figs 1–21. ***Zygaena speciosa speciosa*** **Reiss, 1937**. **1, 2.** ♂, "Iran, Prov. Tehran, | Fasham NE, Gardaneh | Yonza S, 3200–3750| m, 19.7.2010, [41/10] | leg. A. Hofmann". **3.** ♀, same data. **4.** ♂, "N. IRAN, Alborz Mts Prov. Mazandaran | Alam Koh, Hezar-chal | 36°21'N 50°59'E | 3700 m | 28 vii 1997 | leg. Naumann, Nr. 2376". **5.** ♂, red label, "Cotype ♂, *suleimanicola* Reiß 1937 [handwritten], H. Reiss", white label, "Persia sept. | Elburs mts.c.s. | Tacht i Suleiman | Särdab Tal | (Hećerćam) | 4200 m 20.7.37 | E. Pfeiffer & W.Forster | München leg.". **6.** ♂, red label, "Cotype ♂, *speciosa* Reiß 1936 [handwritten], H. Reiss", white label, "Persia s. | Elburs mts.s. | Tacht i Suleiman | Hecarčal-Tal | 28–3200m 3-7.VII 36 | E. Pfeiffer- München leg.", white label, "2.2.1955 | von Güner | zum 40. Geb. | coll. A. Hofmann". **7.** ♀, "IRAN, Tehran | Tehran N, Kuh-e Tochal | S-Seite, 3600–3800 m | 3. u. 4.8.2005, [68/05] | T. & A. Hofmann leg. | ♀ legt Eier [handwritten]". **8.** ♀, "IRAN, Tehran | Tehran N, Kuh-e Tochal |3600–3800 m | 28.6.2006, [15/06] | T. & A. Hofmann leg. larva | e.p. : 12.7.2006". **9.** ♀, "IRAN, Tehran | Tehran N, Kuh-e Tochal | S-Seite, 3600–3800 m | 4.8.2006, [45/06] | A. Hofmann leg.". **10–21.** ***Zygaena speciosa oseyii*** ssp. n., **10.** Holotype, ♂, (CAHO). **11, 12.** Paratypes, ♂, " Iran, Prov. Gilan | Kuh-e Samamus, Javaherdeh | 20 km SSW, 335 –3400 m |15.7.2006, [31/06] | A. Hofmann leg.". **13–15.** Paratypes, ♀, same data. **16, 17.** ♂, " Iran, Prov. | Mazandaran, Toneka- | bon SW, Gardaneh-ye | Tondrokosh (Zarout), | 3270–3350 m, 13.– | 14.7.2010, [38/10] | leg. A. Hofmann". **18.** ♀, "IRAN, Mazandaran | Tonekabon SW, Gardaneh-ye | Tondrokosh (Zarout), 3270– | 3350 m, 14.7. 2006, [29/06] | A. Hofmann & A. Naderi leg.". **19.** ♂, " Iran, Prov. Qazvin | NE, Mo'allem Kalayeh | vic., Kuh-e Khash-Chal | 3390–3430 m | 15.7.2010, [39/10] | leg. A. Hofmann". **20.** ♂, same data, but 3550–3700 m. **21.** ♀, same data. All specimen CAHO.

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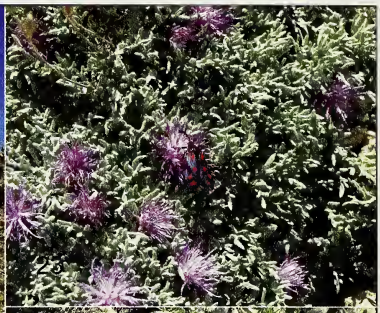
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Etymology. Dedicated to Abbas Oseyi (Karaj), who accompanied the second author when discovering the first population at Kuh-e Samamus.

Description. A group of strictly non-melanistic populations. Black ground colour of forewings with greenish sheen, more greyish and more translucent in females. Hindwings with black border of medium width, stronger at apex and with a double-tooth in the beginning of anal field at the tornus, but never invading the discal area. Forewing spots 1+2, 3+4 and 5 well developed and always present, spots 1+2+2a forming the basal blotch, with spot 2 elongate, longer than spot 1, while spot 2a is vestigial. Spot 3 small, ovoid, spot 4 larger, quadrangular; both spots always separated by the cubitus stem vein. Spot 5 of similar size and form as spot 4, but standing more vertically, isolated from spot 6. The latter (spot 6) more variable: it can be absent in both sexes (20%), but more frequently in the males, it can be vestigial and reduced to a few scales (25%), or well developed as a normal spot in the costal part (25%), or reniform, the upper part then smaller (30%). Red patagia and red abdominal cingulum present on one segment, well developed in females, reduced or vestigial in males. The abdominal cingulum can even be absent or reduced to only a few red lateral scales (20%).

Remarks. Specimens from two other populations that are not from the type-locality are well separated geographically and differ slightly from the type-series; while they can be assigned to *oseyii* subsp. n., they are not included in the type-series.

Diagnosis. In specimens from Gardaneh-ye Tondrokosh (Figs 13–18), spot 6 is always present and larger, the black ground colour of the males is more bluish and the hindwing border is narrower with a very weak expansion at the apex. In specimens from Kuh-e Khash-Chal (Figs 19–21), spots 5 and 6 are mostly closer together and occasionally they are even connected to each other. Otherwise both populations look similar to *Z. speciosa oseyii* ssp. n. from the type-locality (Figs 10–12). The difference between *oseyii* ssp. n. (Figs 10–21) and the nominotypical subspecies from the type-locality in the Alam-Kuh region (Figs 4–6) is extraordinarily strong. In contrast to the nominotypical population from Hezarchal (and from those from Dizin-Shemshak and from Kuh-e Tochal), the more north-westerly located populations (Figs 10–21) from between Kuh-e Khash-Chal and Kuh-e Samamus do not exhibit a tendency for melanism. The hindwings are red with a variable broad border and are never darkened, while the border never forms a "tooth" along the

Figs 22–29. *Zygaena speciosa oseyii* ssp. n., habitats, bionomics. 22. Bolder scree habitat (foreground) near Gardaneh-ye Tondrokosh with view to type-locality (arrow) at Kuh-e Samamus around 20 km as the crow flies north-west. Note the clouds coming up from the Caspian Sea and reaching the northern slopes of the higher Alborz Mountain Chains. **23.** Female moth nectaring on high-mountain composite *Jurinella frigida* (Boiss.) Wagenitz (Compositae) (Gardaneh-ye Tondrokosh, 14.VII.2010). **24.** On *Thymus* sp. (Lamiaceae) (Gardaneh-ye Tondrokosh, 14.VII.2010). **25.** *Valeriana sisymbrifolia* Kabath (Valerianaceae) was the only nectar plant noted at Kuh-e Khash-Chal, 3390–3700 m, 15.VII.2010. **26.** Cushion zone at Gardaneh-ye Tondrokosh, habitat of *Z. speciosa* and a high-mountain population of *Z. carniolica*. **27.** Foggy weather conditions during the flight period of *Z. speciosa oseyii* ssp. n. at its most eastern habitat at Kuh-e Khash-Chal, 3390–3700 m, 15.VII.2010. **28.** Ovipositing female (arrow) on larval host-plant (*Semenovia tragioides* (Boiss.) Manden, Apiaceae) at Kuh-e Khash-Chal, 3390–3700 m, 15.VII.2010. **29.** Cocoon with exuviae on the underside of limestone beside the flowering host-plant (*S. tragioides*), Gardaneh-ye Tondrokosh, 14.VII.2010).

Figs 30–39. Diagnostic characters of male genitalia of *Zygaena speciosa speciosa* (30–32, 36, 37) and *Z. speciosa oseyii* ssp. n. (33–35, 38, 39). **30, 33.** Uncus-tegumen complex. **31, 34.** Lamina dorsalis. **32, 35.** Lamina ventralis. **36, 38.** Valva with vinculum and saccus. **37, 39.** Phallus (Aedoeagus sensu Alberti, 1958) with cornuti.

anal vein. Spot 6 is either strongly reduced or predominantly completely missing in *Z. speciosa speciosa*, while it is predominantly present or at least vestigial in *Z. speciosa oseyii* ssp. n. Not a single specimen from all of these three new localities can be confused with specimens from Alam Kuh, Dizin-Shemshak or from Kuh-e Tochal, nor can any single specimen from these localities be incorporated into the series of *oseyii* ssp. n. The localities of the most easterly population of *oseyii* ssp. n. (Kuh-e Khash-Chal) and *Z. speciosa speciosa* are less than 40 km from each other as the crow flies and, surprisingly, the population nearest to the Alam-Kuh population even exhibits the most reddish forms of all three known populations.

Genitalia. Differences in genitalia structures within species-groups of *Zygaena* (Hofmann and Tremewan 2010) are often poor, especially in the *manlia*-group, and significant characters for separating closely related taxa are obviously lacking (Hofmann and Keil 2011: 244–245), which is why fertile hybrid-crossings in captivity were relatively easily to obtain (Hofmann 2000b, Hofmann and Kia-Hofmann 2010).

We found slight differences in the uncus and lamina dorsalis of the male genitalia between *Z. speciosa speciosa* (Figs 30-32, 36, 37) and *Z. speciosa oseyii* ssp. n. (Figs 33–35, 38, 39), but we do not interpret them as prezygotic mechanisms of isolation. The uncus of the nominotypical subspecies is more cone-shaped, attenuated at the end (compare Figs 30 and 33), while the lamina dorsalis is broadest at the middle part and becomes narrower toward the base (compare Figs 31 and 34), in contrast to *Z. speciosa oseyii* ssp. n. in which this structure is more pyramidal-like, broadest at its base. However, there may be variation in these structures and even if dissections of a series would confirm these as constant characters, they would nevertheless not prevent successful pairings, but may reflect strict isolation with diverse developments in the post-glacial period. Furthermore, if one takes the 100% separation in phenotype into account, a clear tendency for species-specific differentiation on the way to distinct biospecies becomes obvious.

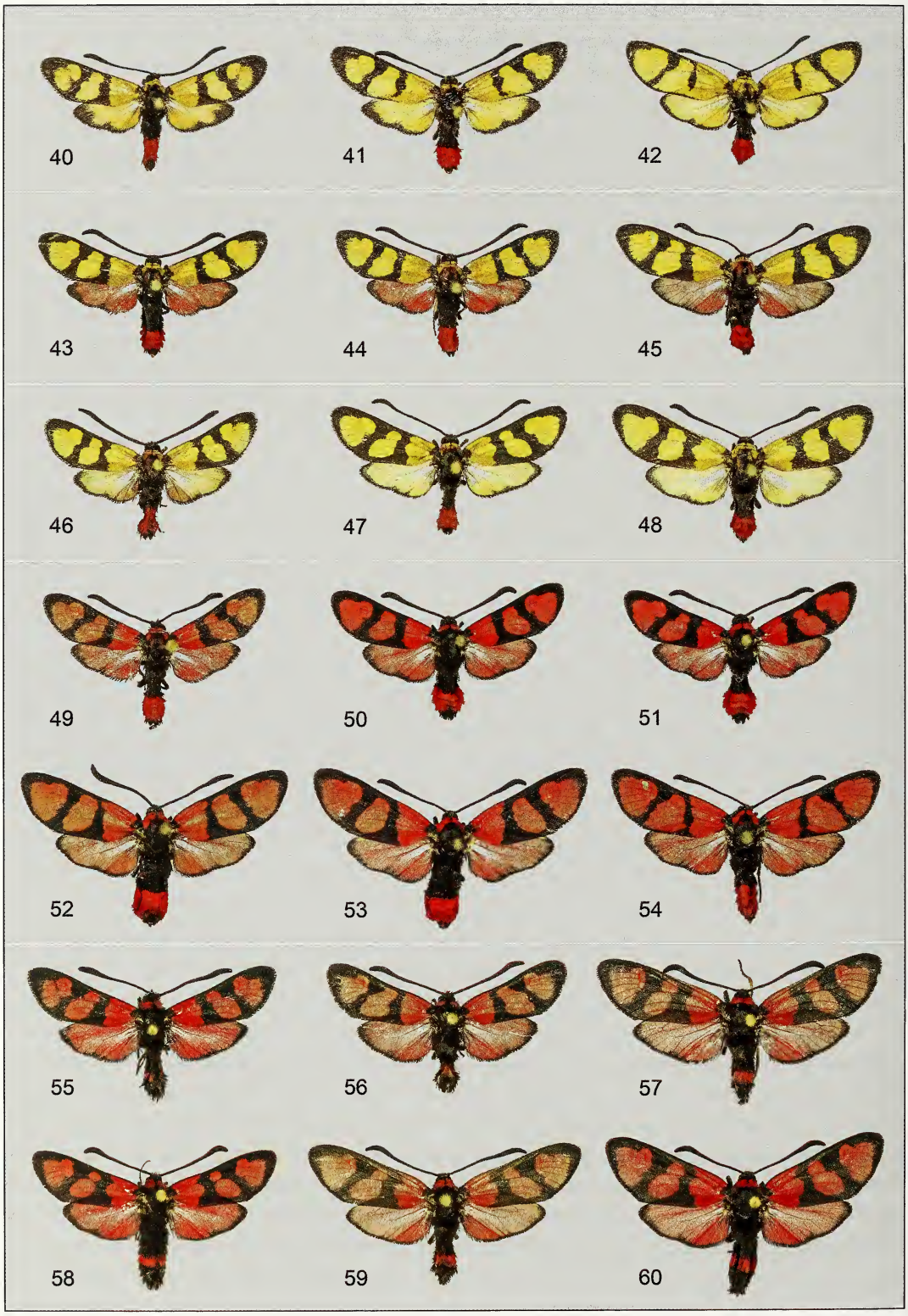
Bionomics. Detailed data on the bionomics with figures of larvae, host-plants and biotopes, together with a distribution map that includes the populations of *Z. speciosa oseyii* ssp. n., have been provided by Hofmann and Kia-Hofmann (2008: 25–49). At all three localities, *Z. speciosa oseyii* ssp. n. is syntopic with *Z. carniolica*.

Distribution. In addition to the type-locality, *Z. speciosa oseyii* ssp. n. is known from two further sites, both of which are located further east of the Kuh-e Samamus (Fig. 22). All three sites are situated at altitudes between 3270 and 3700 m. A gap of *ca.* 40 km between ssp. *oseyii* and ssp. *speciosa* remains unexplored. Further prospecting, especially in the Kuh-e Sialan region, will show that either there is a transitional zone with mixed populations or a sharp divide between the melanistic and 'normal' forms.

Zygaena tamara Christoph, 1889

Figs 40–72

Remarks. The pure red populations of the Kendevan region have been described as ssp. *kendevanica* Tremewan, 1977, and populations with the same phenotype are found further south-west to Zanjan (Figs 49–54). Similar pure red populations occur in the Van Gölü region in eastern Turkey (ssp. *placida* Bang-Haas, 1913), while the Zagros range, the Iranian Talysh and Azerbaijan-e Sharqi are predominantly inhabited by populations with mixed characters of yellow forewings and red hindwings (Figs 43–45) or yellow fore- and hindwings (Figs 40–42, 46–48). A unique character that distinguishes all of these populations of *Z. tamara* from all other *Mesembrynus* species is the red abdominal cingulum that is present on two to three segments in the females and on three segments in the males (Figs 40–54, 63), a character that is in strong contrast to the newly discovered populations from the northern side of the Alborz range, which we here describe as *Zygaena tamara dailamica* ssp. n.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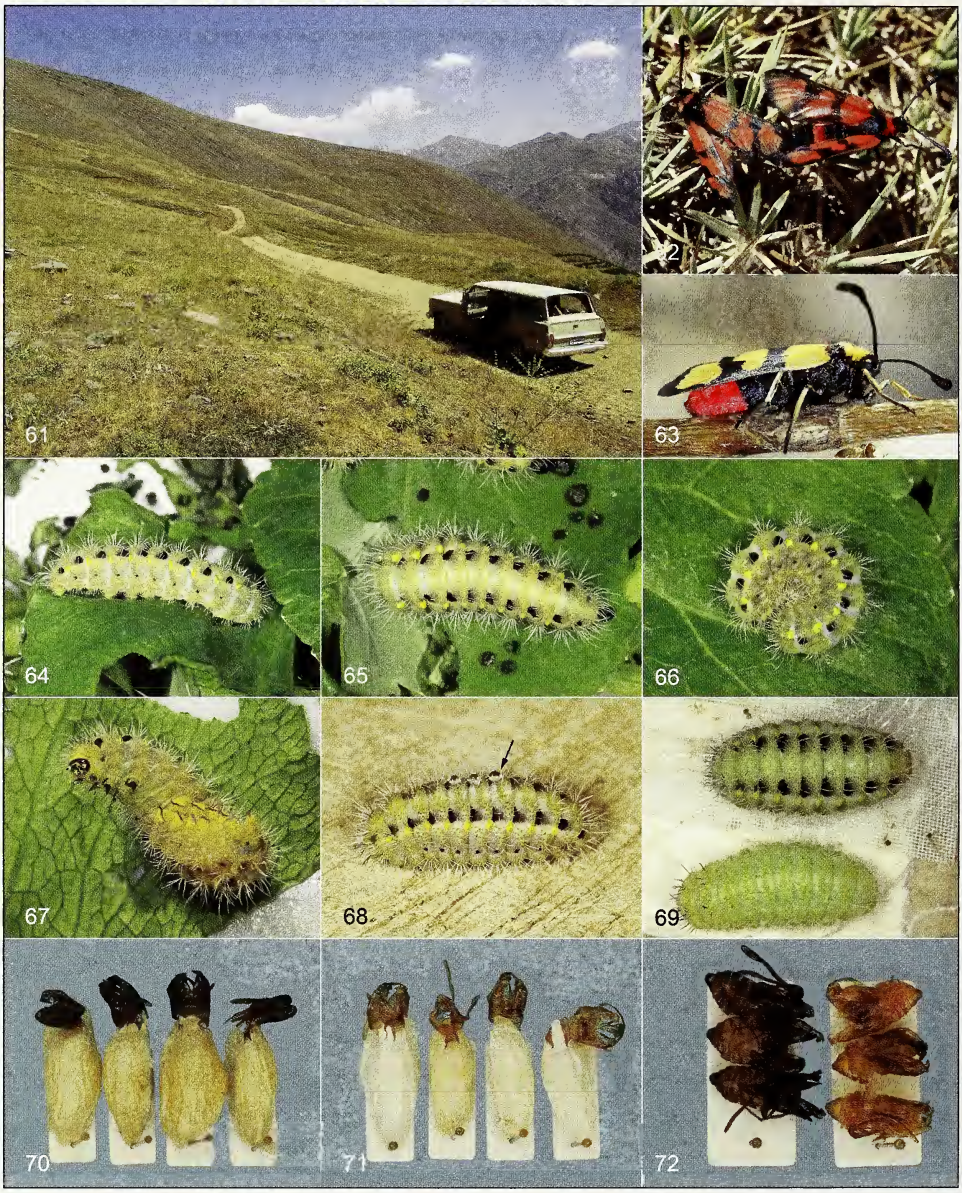
Zygaena tamara dailamica ssp. n.

Figs 55–63, 64–70, 72

Material. Holotype ♂, 31 mm wingspan, "Iran, Prov. Qazvin, Hir NE, Gardaneh-ye Anbarkesh, N-Seite, 2780–2900 m, 13.7.2006, leg. A. Hofmann & A. Naderi", [36°37,46'N, 50°21,34E], coll. A. Hofmann (to be deposited later in SMNK). Paratypes, same data as holotype: 7 ♂, 4 ♀, coll. A. Hofmann; 2 ♂, coll. T. Keil; 3 ♂, 1 ♀, leg. et coll. A. Naderi. Same locality as holotype: 3 ♂, 18.vii.2007, leg. T. & C. Keil, coll. T. Keil. Same locality as holotype, F1, ab ovo, coll. A. Hofmann: 13 ♂, 15 ♀, e. p.: 26.iv.–29.v.2007; 19 ♂, 21 ♀, e. p.: 22.iv.–15.vii.2008; 4 ♂, 2 ♀, e. p.: 27.v.–11.vi.2009. Ibidem, F2: 3 ♂, 7 ♀ (ex CV070523), e. p.: 3.v.–23.vi.2008; 2 ♂, 3 ♀ (ex CV070523), e. p.: 3.–14.vi.2009; 1 ♂, 1 ♀ (ex CV08053,2), e. p.: 27.–30.v.2009. Ibidem, F3: 2 ♂, 3 ♀ (ex CV080503,1), e. p.: 29.v.–28.vi.2009. 10 ♂, 8 ♀, "Iran, Prov. Mazandaran, Tonekabon SW, Tamol vic., 2250–2400 m, 14.vii.2006, leg. A. Hofmann & A. Naderi", [36°38,87'N, 50°25,71'E], coll. A. Hofmann; 2 ♂, coll. T. Keil; 3 ♂, 1 ♀, leg. et coll. A. Naderi; 24 ♂, 6 ♀, 18.vii.2007, leg. T. & C. Keil, coll. T. Keil; 3 ♂, leg. et coll. A. Naderi; 4 ♂, 4 ♀, 13.vii.2010, leg. et coll. A. Hofmann. Ibidem, F1, ab ovo, coll. A. Hofmann: 15 ♂, 28 ♀, e. p.: 22.v.–30.v.2007; 2 ♂, 3 ♀, e. p.: 15.–24.v.2008; 8 ♂, 9 ♀, F2 (ex CV070522,2), e. p.: 30.iv.–15.vii.2008. Ibidem, F2: 2 ♂, 6 ♀ (ex CV070522,2), e. p.: 2.–19.vi.2009; 3 ♂, 4 ♀ (ex CV070524), e. p.: 4.v.–11.v.2008; 6 ♂, 5 ♀ (ex CV070524), e. p.: 1.–11.vi.2009. 2 ♀, "Iran, Prov. Mazandaran, Tonekabon SW, Gardaneh-ye Tondrokosh (Zarout) N, 2800–3000 m, 14.vii.2006, leg. A. Hofmann & A. Naderi", [36°41,35'N, 50°31,96'E], coll. A. Hofmann; 3 ♂, coll. T. Keil; 5 ♂, 2 ♀, leg. et coll. A. Naderi; 1 ♂, coll. P. Zehzad; 3 ♀, 14.vii.2010, leg. et. coll. A. Hofmann. Paratypes will be deposited in HMIM, CWGT.

Etymology. Dailam (persian دیلم) is the historical name of the mountain region on the southwest side of the Caspian Sea. Because of its mountain location Dailam was for a long time protected from the attacks of invading Arabs, its inhabitants much later being converted to Islam. The centre was the Assassin fortress of Alamut, a castle at 2100 m altitude that was regarded as impregnable, but was destroyed in 1275 by the Mongols.

Figs 40–60. ***Zygaena tamara*. 40–42.** ***Z. tamara zuleiqa*** **Naumann & Naumann, 1980. 40.** ♂, "Hakkāri | 1300–2100 m | (Hakkāri) - Turquie | 11 août 1992 | Bernard MOLLET". **41.** ♂, "Türkei, SE Hakkari, Čilo | Dağ, Dez-Tal, 1800– | 2500 m, 15. VII. 2002 | leg. ten Hagen". **42.** ♀, same data. **43–45.** ***Z. tamara mahabadica*** **Reiss, 1978. 43, 44.** ♂, "IRAN, Kurdestan | Sanandaj NW, Saqqez - | Baneh (pass) 1950– 2100 m | 5.7.2005 [51/05] | A. Hofmann & B. Mollet leg.". **45.** ♀, same data. **46 –48.** ***Z. tamara fahima*** **Naumann & Naumann, 1980. 46, 47.** ♂, "Iran | Prov. Esfahan, Ferey- | dun Shahr S, Sibak SE | Kuh-e Sibak, 2700–3000 | m, 13.6. 2010, [23/10] | leg. A. Hofmann". **48.** ♀, same data. **49–54.** ***Z. tamara kendevanica*** **Tremewan, 1977. 49.** ♂, "IRAN | Zanjan- | Gilvan | 1, Paß ca. 1 km N | Garovol Dag | 2400–2500 m | 3.–4.7.1999 | A. Hofmann & J.U. Meineke leg.". **50, 51.** ♂, "IRAN F1, e.o. | Zanjan-Gilvan | Gargovol Dag, 1, Paß, ca. 1 km N | des Passes, 2400–2500 m e.p. : | 23.4.–3.5.2002 | A. Hofmann cult.". **52 – 57.** ♀, same data. **55–60.** ***Z. tamara dailamica*** **ssp. n.. 55.** Holotype, ♂, "IRAN, Qazvin | Hir NE, Gardaneh-ye | Ambarkesh, N-Seite, 2780– | 2900 m, 13.7. 2006, [16/06] | A. Hofmann & A. Naderi leg.". **56.** Paratype, ♂, "IRAN, Mazandaran | Tonekabon SW, Tamol vic. | 2250–2400 m | 14.7. 2006 [28/06], A. Hofmann & A. Naderi leg.". **57.** Paratype, ♀, same data. **58.** Paratype, ♂, "IRAN e.o. | Prov. Qazvin Hir NE | Gardaneh-ye Ambarkesh | N-Seite, 2780–2900 m | [26/06], e.p. : 26.4. – 29.5.2007 | T. & A. Hofmann cult.". **59.** Paratype, ♀, "Iran, Prov. | Mazandaran Tone- | kabon SW, Tamol vic. | 2250–2400 m | 13.7. 2010 [37/10], leg. A. Hofmann ". **60.** Paratype, ♀, "IRAN e.o. | Prov. Mazandaran, | Tonekabon SW, Tamol vic. | 2300 m, [28/06] | e.p. : 15.–24.5.2008 | T. & A. Hofmann cult.".



Figs 61–72. *Zygaena tamara and Z. tamara dailamica* ssp. n., habitats, bionomics. 61. Treeless, high-mountain steppe habitat above Tamol (13.vii. 2010), dominated by cushions, thorny and spiny vegetation and grasses. **62.** Copula of *Z. tamara dailamica* ssp. n. on *Acantholimon* cushion (Plumbaginaceae) (Gardaneh-ye Tondrokosh, 13.vii.2010); note the single red abdominal cingulum. **62.** *Zygaena tamara mahabadica*, e.o., e.p. 29.v.2009; note the red abdominal cingulum over three segments. **64–68.** Final instar larva (lateral, dorsal, ventral views) of *Z. tamara dailamica* ssp. n. (1.–12.V.2009, Gardaneh-ye Ambarkesh). **69.** Comparison of fully-grown larvae of *Z. tamara dailamica* ssp. n. (above) from type-locality and *Z. tamara mahabadica* (Iran, Kurdestan, Baneh vic.) (below). **70.** Cocoons with exuviae of *Z. tamara dailamica* ssp. n. **71.** Cocoons with exuviae of *Z. tamara mahabadica* (Iran, Kurdestan, Baneh vic.). **72.** Comparison of exuviae of *Z. tamara dailamica* ssp. n. (dark brown) from type-locality and *Z. tamara mahabadica* (Iran, Kurdestan, Baneh vic.) (light brown).

Description. Black ground colour with greenish or greyish sheen. Coloration of forewing spots warm red but without a tendency to orange. Hindwings less densely scaled, slightly translucent. Spots 1+2+2a forming a large basal blotch that is always well separated from the spot pair 3+4. Spot 3 smaller than spot 5, connected to the largest spot (spot 4). Spot 5 quadrangular, attached to spot 6, in the majority with a groove in the upper part, occasionally isolated, especially in the males. Spot 6 large, pear-shaped when separated from spot 5. Spot 6 completely absent in one female. Hindwings with a narrow greyish black border that can be broadened slightly at the apex. Red patagia and red abdominal belt always present on one segment, the latter closed ventrally. Tegulae consistently black in males, in females sometimes mixed with a few red scales. Legs greyish white in both sexes.

Diagnosis. Imago: From all other populations of *Z. tamara* the new subspecies is well separated by the one-segmented red cingulum on the abdomen (Fig. 62). Moreover, the red coloration is colder, less orange than in the red populations of *Z. tamara* (*Z. tamara placida*, *Z. tamara kendevanica*). The distance between the spot pairs 1+2+2a and 3+4 of these subspecies is broader than that in *Z. tamara dailamica* ssp. n., thus forming a broad black band of ground colour.

Preimaginal stages: Already the L1 larva is darker than larvae of *Z. tamara* from other localities. This is even more obvious in the diapausing stage. Post-diapause larvae and fully-grown larvae exhibit a more dirty-yellow ground colour with more brownish grey-yellow on the verrucae. While the fully-grown larvae of *Z. tamara* are nearly unicolorous without contrasting elements, those of *dailamica* ssp. n. are much more strongly marked with the anterior dorsal spots (ADS) well developed and the yellow dorso-subdorsal spots well visible and present on 10 segments (Figs 64–69). Moreover, constant differences exist in the sclerotization of the pupae and even in the coloration of the cocoon (Figs 70–72). The exuviae of *dailamica* ssp. n. are dark brown, in contrast to the light- to mid-brown coloration in all other known populations of *Z. tamara*. The coloration of the cocoon is consistently slightly darker, less yellowish but light white-brownish with a tinge of green. Cocoons of *Z. tamara* from Zanjan, Baneh (Kurdestan), Golujeh (Azerbaijan-e Sharqi) or from Dorud (Lorestan) are light yellow to white (Fig. 71).

Bionomics. All habitats of Z. *tamara dailamica* ssp. n. are treeless slopes with a combination of arboreal, oreal and eremic vegetation, e.g. *Securigera varia* (L.) Lassen (Fabaceae) is found in the immediate vicinity of *Onobrychis cornuta* (L.) Desv. (Fabaceae), *Eryngium billardieri* Delar. (Apiaceae), *Astragalus* (*Tragacanthus*) (Fabaceae) cushions and yellow-flowering *Phlomis* (Lamiaceae), typical for the narrow transitional zone between the humid Hyrcanian and the more arid eremic regions. At the first locality (Gardaneh Anbarkesh), Z. *tamara dailamica* ssp. n. is syntopic with *Z. cambysea* Lederer, 1870, while at the more northerly sites it is syntopic with *Z. haberhaueri* Lederer, 1870. In the more humid valley that lies between the two mountain ranges, where there is intensive agriculture, plenty of orchards and many villages, only *Z. loti* (Denis & Schiffermüller, 1775) and *Z. dorycnii* Ochsenheimer, 1808, were found; just 100–200 m higher up, the vegetation changes rapidly and becomes much drier and is partly grazed intensively by goats and sheep. These are the biotopes where, in the vicinity of Tamol, Z. *tamara dailamica* ssp. n. and *Z. haberhaueri* were accompanied by these two species, a faunistic combination that is atypical for *Z. tamara*. In its biotopes, *Z. tamara* is usually accompanied by species typical of the Zagros arid climate, e.g. *Z. turkmenica* Reiss, 1933, *Z. escalerai* Poujade, 1900, *Z. rosinae* Korb, 1903, Z. *cambysea*. The sympatry in the vicinity of Tamol represents a faunistic mixture comprising two species that are typical for the northern side of the Alborz Range (*Z. dorycnii*, *Z. loti*), while the latter species does not even cross the Alborz main chain to the south.

After 10.00 h, moths were observed nectaring at the pinkish flowers of *Salvia*, but preferred to sit on the flower heads of some Dipsacaceae, viz. a white and bluish *Scabiosa* sp. and a tall white-flowered *Cephalaria* sp. Several copulae were found sitting on dry stems or on the flowers of scabious during the afternoon after 15.00 h, rarely on cushions of an *Acanthophylum* sp.

Distribution. *Zygaena tamara dailamica* ssp. n. was found only at altitudes between 2250–3000 m. Its distribution is restricted to the central Alborz range between north of Qazvin and south of Tonekabon and extends over two north-westerly/south-easterly ranging mountain chains with a valley of 1700–1900 m in between. In its most northerly sites *Zygaena tamara dailamica* ssp. n. inhabits slopes that are open to the Caspian Sea.

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We thank Prof. Dr Gerhard Tarmann and Dr W. Gerald Tremewan for help and fruitful discussions; moreover, the latter kindly improved an earlier draft of this manuscript. Host-plants and nectar plants were kindly determined by Dr Amirhossein Pahlevani (Bayreuth). Dr Tabassom Kia-Hofmann helped with the cultures and paid careful attention to the feeding larvae when the first author was away on expedition. For companionship and patience during the quite difficult tours to Kuh-e Samamus and over the passes between Qazvin and Tonekabon we thank our Iranian friends Messrs Mustafah Selahi, Hamid Mohareri, Abbas Oseyi and Ali Mohajeran. The peer reviewers and the editor are thanked for valuable advice which essentially improved the manuscript.

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(see Hofmann & Tremewan, 2001: 133–136, Hofmann & Kia-Hofmann, 2008: 51, 52)

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Book Review: The Afrotropical Scythrididae, Esperiana Memoir 7

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Bengt Å. Bengtsson 2014: The Afrotropical Scythrididae, Esperiana Buchreihe zur Entomologie Memoir 7: 1–365. ISBN: 978-3-938249-05-5. Price: €125.

This book comes nicely bound, of a convenient size, with an ample supply of colour pages like others in the Esperiana Memoir series. The abstract details nine new synonymies and mentions that 191 new species are described out of the 307 treated.

There is a brief introduction to the family Scythrididae and an account of previous treatments of the family from the Afrotropical Region. All the localities taken from data labels of specimens examined are listed together with their longitude and latitude coordinates. There follows a section on Systematic aspects of the family and a list of genera with synonyms; no new genera are proposed. There is then a "Tentative systematic list" giving the names of all species to be treated in this work, these comprise six smaller genera: *Apostibes, Bactrianoscythris, Enolmis, Eretmocera, Haploscythris* and *Paralogistis.* Then the genus *Scythris* is divided into 18 species groups, after which are "Isolated species" which could not be grouped together with other species.

The bulk of the text then follows, comprising a description or redescription of each of the species, followed by a few photographs of localities and 23 pages of colour photographs of the adult specimens, and two of larvae. There are then 45 pages of monochrome photographs of male genitalia and 47 pages of female genitalia.

The species are all given a number and the illustrations are labelled with the same number, imagines with suffix -i, male genitalia with suffix -m, female genitalia with suffix -f with an additional suffix when more that one photograph was deemed necessary. This seems to be a sensible and helpful arrangement. Since the male genitalia are so diverse and difficult to interpret parts are labelled with arrows at times when the parts might be easily confused. All the photographs of adults are presented in a rectangle of the same size; it is easy in this computerised age for this to be done and they fit conveniently into a page. However even though a scale bar is included one does lose the sense of whether a species is a large or small one and I personally would prefer to have them reproduced at a constant scale.

The author has chosen type material to illustrate specimens whenever possible and this must be commended, and in the text the location of the holotype is specified.

Since I was asked to check the English I have to accept responsibility and not blame the author for one recurring error: the derivation of each new name is given under the heading "Ethymology" which of course should read Etymology.

No doubt a professional entomologist with more resources at his disposal would have had recourse to analysis of the DNA of some genera and species so that a robust structure for the family could be attempted. He would no doubt have examined other collections such as those at Tervuren

and elsewhere which was not attempted by this author. This work was compiled by a retired teacher who has also undertaken other works during the same decade. Scythrididae are not a group of great economic importance. Zhang B-C. (1994) in his *Index of Economically Important Lepidoptera* listed only two species of Scythrididae which had been mentioned in the economic literature, and both of them were from Asia. This means it is never likely that funding would be available for such a work as this.

A publication of this type does raise some deeper questions. The Afrotropical Region is vast; the Democratic Republic of Congo alone is the size of Western Europe. Scythrididae tend to inhabit semi-arid areas and Africa is a pretty arid continent, so the complete Scythridid fauna must be enormous, perhaps several times the 307 species described. It was a daunting task which the author embarked upon, but he has made a start and some of the species encountered can now be named. It is pleasing to have a book to handle in a traditional way, but to an African worker the cost might amount to a month's salary, even a museum or university in the Afrotropical Region might not be able to justify the outlay. Open access online publications, whilst less attractive to people of my generation, are certainly more likely to be consulted by someone working in Africa. We have a good grasp of the European fauna and it is natural for us to want to document the whole of life on earth, but the transition to tropical areas introduces a different order of scale; one wonders whether or not it can be achieved before that fauna is irretrievably damaged or destroyed.

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